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PREFACE

Agricultural Finance Review provides a forum for presentation of research and discussion of issues in agricultural finance. This regular annual publication contains articles contributed by scholars in the field and refereed by peers. Publication is annual except for special issues. A special issue of Volume 47 was published in March 1987.

Volume 43 was the first to be published at Cornell University. The previous forty-two volumes were published by the U.S. Department of Agriculture. AFR was begun in 1938 by Norman J. Wall and Fred L. Garlock whose professional careers shaped much of agricultural finance research for many years. Professional interest in agricultural finance has continued to grow, involving larger numbers of people and a greater diversity in research topics, methods of analysis, and degree of sophistication. We are pleased to be a part of that continuing development. We invite your suggestions for improvement in *Agricultural Finance Review.*

The effectiveness of this publication depends on its support by agricultural finance professionals. That support has grown each year in terms of manuscripts received and reviews of manuscripts. Eighteen manuscripts were received for this volume, and thirty-one individuals provided reviews—some more than one. We express thanks to those whose names are listed below. Grateful appreciation is also expressed to the Economic Research Service, USDA, for partial financial support. In addition, page charges and Myers Estate funds support this publication.

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PCA Costs and Differential Pricing

Martin Fischer and Glenn Pederson

Abstract

Some cooperatives have interpreted the principle of service at cost to mean equal pricing for all customers. However, differential pricing based on costs of serving different customers may be more equitable. For this reason cooperatives—Production Credit Associations (PCAs) in particular—need to understand and measure costs of serving different customers. A method of allocating PCA operating expenses to customers of different size and credit quality is developed and applied to PCAs in the St. Paul Farm Credit District. Pricing issues are discussed in light of empirical results.

Key words: cooperative, PCA, costs, loan pricing.

Service at cost is a basic principle of cooperation. One interpretation of that principle is that members should pay the same price for products or services purchased from, and receive the same price for products marketed through, their cooperative.[1] The "equal price" interpretation of the service at cost principle leads to sharing of costs in proportion to volume of patronage. If costs of serving members are proportional to volume, then it seems reasonable, fair, and practical for cooperatives to practice equal pricing. Equal pricing may be unreasonable and unfair if costs of serving members are not proportional to volume. Equal pricing is also likely to be impractical when unit costs of serving members differ. For example, if differences in unit costs are associated with member volume, equal pricing may cause large-volume, low-unit-cost members to exit (Black and Knutson; Staatz).

We advocate an alternative interpretation of the service-at-cost principle. Each cooperative member should bear costs in proportion to his contribution to the cooperative's total costs, not in proportion to volume. We refer to that interpretation as *differential pricing.* To implement a differential pricing policy consistent with this interpretation of service at cost, it is essential to identify the cost of serving different members. Typically, cooperatives do not keep track of the costs of serving individual customers. Therefore, data required to implement differential pricing are not readily available. An important theoretical and empirical issue is whether costs of serving individual members can be inferred from available accounting data.

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[1]This interpretation is either implicit or explicit in most models of cooperatives, including those developed by Enke, Clark, Phillips, Helmberger and Hoos, Hardie, Royer, and Fischer.

In financial institutions, differences in customer size and credit quality are primary sources of differences in unit costs of serving customers. Differential pricing based on credit quality has recently become widespread within the Farm Credit System. The change in pricing policy was triggered by the exodus of high quality borrowers that occurred under the former equal pricing policy. As agriculture evolves toward a bimodal structure, differentiation based on customer size may become imperative for success of the Farm Credit System, particularly if there are significant differences in unit costs associated with customer size.

This paper addresses the costs of serving PCA customers, and the related issue of pricing of PCA loans. Models of expenses allocable to specific members and of PCA operating expenses are presented. Under the assumptions of the models, the parameters of the individual member expense equation appear in the PCA operating expense equation. Procedures for estimating model parameters from available PCA accounting data are developed in section two. The third section presents results relating to economies of size and costs of serving customers of different size and credit quality. Implications for loan pricing are discussed in section four.

Model of PCA Operating Expenses

PCA expenses consist of operating expense, loan loss provision, and cost of funds. Our focus in this section is on operating expense and its allocation among customers. Other expenses are discussed below under loan pricing.

PCA operating expenses are viewed as either those that are directly allocable to serving individual customers or "overhead," which is not directly allocable. Allocable expenses might include: (*a*) the cost of loan officer and support staff time spent with the specific customer; (*b*) the cost of establishing and maintaining records of the borrower in the loan file, loan accounting system, and member information data base; (*c*) costs arising in conjunction with credit analysis, repayment monitoring, loan review and classification, and collateral inspection, perfection, and monitoring for the specific customer; and (*d*) other expenses for which a reasonable basis exists for allocation to specific customers.

In principle, a PCA could allocate many of its operating expenses to individual customers—perhaps on the basis of loan officer time spent on each customer. In practice, expense allocation to specific PCA customers would require cost accounting at the level of the individual customer. Such an accounting system could be prohibitively costly. In any event, PCAs do not have individual customer cost accounting, and for that reason, no data exist on the costs of serving specific PCA customers.

If allocable expenses could be observed, we would expect them to exhibit three properties. First, some portion of allocable expenses would be fixed, that is, independent of the amount borrowed by the customer or other characteristics of the customer. For example, loan accounting and management information system costs are likely to be approximately independent of customer loan size and other characteristics. Second, some allocable expenses would likely vary directly with loan size. Resources expended in credit analysis and collateral verification and monitoring, for example, increase directly with loan size. Third, allocable expense will be greater (for a given loan size) if the loan is in *special credit* (classified vulnerable or loss) than if the loan is in *regular credit* (classified acceptable or problem). This is due to added servicing requirements for special credit loans. Given that characterization, we assume that expense allocable to specific customers satisfies the following equation:

$$exp_i = a + b \cdot v_i + c \cdot s_i \cdot v_i, \qquad (1)$$

where exp_i is expense allocable to customer i, a is fixed allocable expense (the amount of allocable expense that is independent of customer characteristics such as loan size or credit quality), v_i is loan volume (average balance) for customer i, s_i is a dummy variable indicating whether the loan is a special credit ($s_i = 1$) or a regular credit ($s_i = 0$), and b and c are parameters.

Corresponding to (1) is the following average allocable expense function for specific customers:

$$ae_i = a/v_i + b + c \cdot s_i, \qquad (2)$$

where ae_i is average allocable expense for customer i (e.g., allocable expense per $1,000 of loan volume). Average allocable expense is inversely related to loan size. The special credit dummy acts as a shift variable in the average allocable expense equation. The hypothesized inverse relationship between ae_i and v_i provides a rationale for differential pricing based on loan size, while the direct relationship between ae_i and s_i provides a rationale for differentiation based on credit quality.

PCA overhead expense traditionally includes administration, advertising, association accounting, and general expense. We define overhead to be those operating expenses for which no self-evident basis for allocation to individual customers exists. Some of the traditional overhead expense items might reasonably be allocated to specific customers under a customer-level cost accounting system. In any case, there are presumably some expenses that would necessarily be treated as overhead items. The issue of how those expenses should be allocated among members in order to recover all costs is discussed below.

Total PCA operating expense is the sum of expenses allocable to specific customers plus overhead.

$$EXP = \sum_i exp_i + O, \quad i = 1, \ldots, N, \qquad (3)$$

where EXP is total operating expense, N is the number of PCA customers, and O is overhead. Substituting from equation 1 gives

$$EXP = a \cdot N + b \cdot V + c \cdot SV + O, \qquad (4)$$

where $V\ (= \Sigma_i\ v_i)$ is total loan volume (average balance) and $SV\ (= \Sigma_i\ s_i\ v_i)$ is total special credit loan volume. Total PCA operating expense consists of variable expenses (which vary directly with number of customers, total volume, and special credit volume) and overhead.[2]

The PCA average operating expense is

$$AE = a/(V/N) + b + c(SV/V) + O/V, \qquad (5)$$

where AE is PCA average operating expense. Equation 5 states that PCA average expense is inversely related to average loan size (V/N), directly related to the proportion of special credit volume in the PCA's portfolio (SV/V), and inversely related to total PCA volume (V). The importance of economies of PCA size is determined by the magnitude of overhead.

Equation 1 could not be empirically verified because no expense data for individual customers exist, but data necessary to estimate equation 4 are available. Moreover, the parameters (a, b, and c) in equation 4 are, under our assumptions, the same as those in (1), so that estimation of (4) provides parameter estimates for (1) as well. Data required to estimate (5) are also available. Whether (4) or (5) provides better estimates of the parameters is an empirical issue.

Estimating Procedure

The nature of the estimating problem is such that either the total or average PCA

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[2]Equations 1 and 4 may be viewed as special cases of a more general model in which both the intercept and the slope of the allocable expense equation are influenced by numerous customer characteristics. In practice, ability to test the general model may be hampered by lack of data on characteristics of members or by insufficient degrees of freedom.

A particular variation would be to hypothesize a nonlinear relation between customer cost and member volume. For example, a piecewise linear relation could be hypothesized:

$$\begin{aligned} exp_i &= a + b \cdot v_i + c \cdot s_i \cdot v_i, && \text{if } v_i \leq \bar{v} \\ &= a' + b' \cdot v_i + c' \cdot s_i \cdot v_i, && \text{if } v_i > \bar{v}. \end{aligned}$$

This specification assumes that fixed and marginal member costs differ for different size classes. It can be generalized to any number of size classes, and customer costs can be aggregated to identify a PCA expense function. However, estimation requires data on number, volume, and special credit volume for each size class of member. The data were not available.

expense equation (or possibly both) will be characterized by heteroscedastic disturbances. Suppose the usual ordinary least squares (OLS) hypothesis is maintained with respect to the following total operating expense equation:

$$EXP_j = a \cdot N_j + b \cdot V_j + c \cdot SV_j + O + \mu_j, \quad (6)$$

where j denotes the jth PCA and μ_j is a random variable with mean zero and constant variance (σ^2). The corresponding hypothesis for the average expense equation is

$$AE_j = a(N_j/V_j) + b + c(SV_j/V_j) + O/V_j + \mu_j/V_j \quad (7)$$

The disturbance term in (7) has a zero mean but has variance σ^2/V_j^2 (i.e., the disturbance term is heteroscedastic).

If, on the other hand, the disturbance term for the average expense equation is hypothesized to have a constant variance, then the disturbance term for the total expense equation must be hypothesized to have a variance proportional to V_j^2. Heteroscedasticity is inevitable in at least one (and possibly both) of the PCA expense equations. Although OLS yields unbiased and consistent parameter estimates under heteroscedasticity, the estimated parameter variances are biased, and the t-tests for parameter significance are invalid (Pindyck and Rubinfeld, pp. 141–2).

Preliminary estimates of the total and average expense equations were obtained by OLS. Visual inspection of residuals from the total expense equation plotted against V gave no indication that a quadratic volume term was needed. There was, however, a clear indication that the residual variance increased with volume, and the Goldfeld-Quandt test confirmed that heteroscedasticity was present.[3]

To correct for heteroscedasticity various Park-Glejser tests, concerning the nature of the relation between residual variance and PCA volume, were conducted.[4] Those tests led to a revised empirical model in which residuals are proportional to the square root of volume, and residual variance is proportional to volume:

$$\begin{aligned} EXP_j &= a \cdot N_j + b \cdot V_j + c \cdot SV_j + 0 + \xi_j, \\ \xi_j &= \mu_j v_j^{1/2}, \\ VAR(\xi_j) &= \sigma^2 V_j, \end{aligned} \quad (8)$$

where μ_j is a homoscedastic error term with constant variance (σ^2) and zero covariance. Under that hypothesis, it is appropriate to use a generalized least squares (GLS) approach. Specifically, each variable in (8) is transformed (weighted) by dividing by $V_j^{1/2}$. OLS is applied to the transformed variables and yields unbiased and consistent estimates of both parameters and parameter variances.

The hypothesis regarding the average expense equation, which corresponds to equation 8, is that the disturbance term in the average expense equation is $\mu_j/V_j^{1/2}$ with variance σ^2/V_j. Application of GLS to the average expense equation entails transformation of each variable by multiplying by $V_j^{1/2}$ and applying OLS to the transformed variables. GLS estimators for the average expense equation and total expense equation are identical under the hypothesized error structure, *because the transformed variables are identical for each equation.*[5]

Cross-section data for twenty-nine PCAs in the St. Paul Farm Credit District were used to estimate the parameters of interest. Data and definitions are reported in Table 1.

Results

GLS parameter estimates for the total (and average) PCA expense equation are reported

[3]See Pindyck and Rubinfeld (p. 148), or Johnston (p. 219) for a description of the Goldfeld-Quandt test for heteroscedasticity. We also tested an intercept shifter for large versus small PCAs. The shift dummy was not significantly different from zero, indicating no difference in overhead for large versus small PCAs.

[4]Pindyck and Rubinfeld (pp. 150–51) and Johnston (pp. 219–20).

[5]The fact that the average and total expense equations are characterized by heteroscedasticity implies that GLS is generally appropriate for estimating cost equations.

in Table 1. All GLS parameters are significant at the .90 probability level. The R^2 for the weighted model (.9878) is quite high, but it does not provide a useful measure of goodness of fit for the original (unweighted) model. The R^2 for the unweighted model is recommended as a measure of goodness of fit (Pindyck and Rubinfeld). It is computed as the squared correlation between actual and predicted expenses with predicted values based on the GLS parameters in the total expense equation. The unweighted model has an R^2 of .9405.

Actual versus predicted values of total PCA operating expense are shown in Figure 1, panel A. Actual versus predicted values of PCA average expense (operating expense per $1,000 of loan volume) are shown in panel B of Figure 1 together with the PCA average operating expense curve. The average expense curve was derived using mean values of explanatory variables (*N/V*) and (*SV/V*) in order to illustrate economies of PCA size. There are significant economies of PCA size. Operating expense per $1,000 for a PCA with an average value of (*SV/V*) and an average value of (*N/V*) is predicted to be $28.89 if PCA volume is $40 million, $27.17 if volume is $80 million, and $26.60 if volume is $120 million (Table 2). Overhead is estimated to be $137,528, which is $174 per member in a hypothetical small PCA but

Table 1. Data Used in Estimation[a]

Observation	Average Volume (000)	Number of Borrowers	Special Credit Vol. (000)	Operating Expense
1[b]	$11,216	304	$12,484	561,565
2	13,369	438	7,376	615,106
3	21,168	510	6,340	715,868
4	22,735	435	9,116	876,715
5	25,279	638	16,913	872,394
6	25,358	422	17,126	739,864
7	28,536	580	14,918	798,443
8	34,799	700	19,455	909,216
9	43,250	763	33,145	1,246,650
10	49,986	849	7,827	1,219,093
11	62,493	1,406	20,844	2,111,401
12	65,784	1,540	20,617	1,913,186
13	66,493	1,201	22,342	1,869,311
14	68,418	969	20,117	1,308,041
15	70,922	1,629	11,542	2,190,730
16	75,074	1,459	22,204	1,902,847
17	76,260	1,304	70,363	2,448,673
18	76,795	1,327	16,992	1,604,269
19	79,490	1,500	34,134	1,754,125
20	80,987	1,641	26,825	2,420,574
21	81,609	1,589	26,763	1,933,637
22	100,484	1,532	29,941	2,164,178
23	101,256	1,953	8,631	2,349,145
24	103,075	1,404	30,383	2,746,465
25	107,387	2,609	40,152	3,016,996
26	136,414	1,829	41,661	3,060,970
27	140,518	2,406	40,645	3,332,186
28	143,691	2,738	33,941	3,075,553
29	165,714	2,648	51,389	4,528,166
30[c]	63,382	1,142	55,528	2,950,729

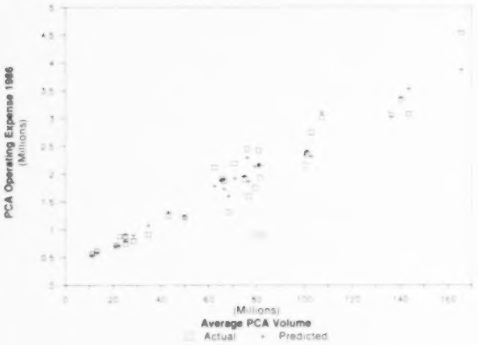
[a]Expense data used in the study were year-to-date operating expenses through October 1986, multiplied by 1.2 to approximate annual operating expense. The approximation was necessary because the study was conducted prior to the time that year-end financial data were available and five of the smaller PCAs merged with others in November of 1986, resulting in severe loss of degrees of freedom if later operating expense data were used. Average volume is average month-end volume through October 1986. Number of borrowers and special credit volume are as of October 31, 1986.

[b]Observation 1 represents a PCA that had recently absorbed several counties from other PCAs. Its average volume through October 1986 was considerably less than its volume as of October 1986.

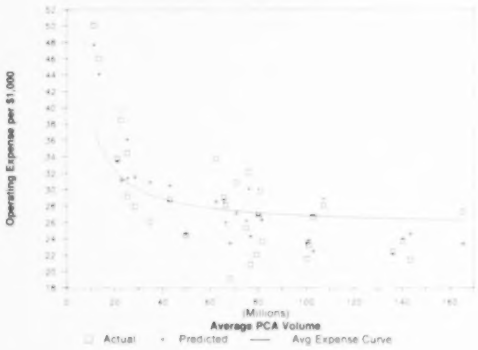
[c]Observation 30 was determined to be an outlier and was omitted from the estimations.

Figure 1. Operating Expense/Volume Relationships for PCAs in the St. Paul Farm Credit District, 1986

Panel A. Total Operating Expense



Panel B. Operating Expense Per $1,000 of Volume and Average Expense Curve



only $58 per member in a large PCA. The $116 per member difference in operating expense provides some motivation for further consolidation of small PCAs.

Based on the theoretical model, expenses allocable to individual PCA customers can be estimated using parameters of the PCA operating expense equation. Table 3 provides estimates of allocable expense for regular and special credit customers of various sizes. Cost economies due to customer size are evident. Average allocable expense for regular credit customers is $38.71 (per $1,000) if customer volume is $20,000, but it declines to just $13.34 if volume is $250,000. The cost of serving special credits exceeds the cost of serving regular credits by $8.42 ($= \hat{c}$) per $1,000.

The results pertain to St. Paul Farm Credit District PCAs for 1986. Changes in lending practices, initiated partly in response to the findings, will undoubtedly change the relationship between customer size and allocable expense per $1,000 in the future.[6] Furthermore, the average operating expense curve will shift down as the district's operating plan calls for sharp cuts in operating expenses with stable loan volume. Although the changes in lending practices will alter the empirical results derived from the model, the methodology provides quantitative evidence concerning the relationship between customer size and credit quality and the cost of serving PCA customers. The results indicate there are substantial differences in unit costs of serving members of different size and credit quality.

Implications for Loan Pricing

To recover allocable operating expenses, a pricing policy (consistent with our interpretation of service at cost) would be to charge a fixed annual loan fee of $\hat{a}$ dollars per customer, plus a spread equal to $\hat{b} \times 10$ basis points for regular credit customers, and $(\hat{b} + \hat{c}) \times 10$ basis points for special credit customers. Institution of a loan fee would provide for continuous differential pricing based on customer size, while the special credit surcharge would achieve differentiation based on credit quality.[7] A member relation problem could

[6] As a result of evidence that unit costs of serving small customers are high, the St. Paul District initiated a "small loans program," under which costs of servicing small loans will be reduced by servicing the loans less intensively. Policy was changed to permit and encourage PCAs to charge loan fees on small loans in recognition of the higher unit cost of serving those loans.

[7] Available data did not permit us to identify differential costs of serving customers with different types of loans (i.e., term or operating loans). The model does not address the timing or frequency with which fixed customer costs are incurred and fees are assessed for different types of loans. In practice, many of the fixed customer costs are incurred at the time of renewal or in the first year of term loans. Loan fees would be charged at those times.

Table 2. GLS Parameter Estimates and Summary Statistics for PCA Operating Expense Equations

Variable	Transformed Variable	Parameter	Estimated Parameter	Standard Error	*t*-Ratio
N	$N/V^{1/2}$	*a*	551.58	198.90	2.773
V	$V/V^{1/2}$	*b*	11.135	3.636	3.062
SV	$SV/V^{1/2}$	*c*	8.420	3.813	2.208
Intercept	$1/V^{1/2}$	*O*	137,528.1	68,593.6	2.005

R^2 = .9878 (weighted model)

R^2 = .9405 (unweighted model, total expense equation)

F = 504.3

arise if a member is transferred from regular to special credit, and the interest rate is increased. That problem could be minimized by making the classification dependent on objective credit factors and by clearly explaining to members how those factors are weighted when classifying loans.

Other pricing issues include pricing to recover cost of funds, overhead, provision for loan loss, and contributions to net income. Detailed analysis of those issues is beyond our scope, but some comments are warranted.

Cost of funds is the largest component of PCA expense. In our view, a reasonable basis for sharing that expense is in proportion to volume. This may be achieved by charging the same basic interest rate (equal to the average cost of funds) to all customers, then adding spreads and fees to cover other expenses.

Three alternative methods for recovering overhead expense are: method A, an equal assessment of $\hat{O}/N$ per member, perhaps in the form of a membership fee; method B, in proportion to volume, by adding $(\hat{O}/V) \times 10$ basis points to the spread; or method C, in proportion to each member's contribution to the PCA's allocable operating expense. Method A favors large borrowers, and method B favors small borrowers. Method C may be most compatible with our interpretation of service at cost. Table 4 illustrates how various members of a hypothetical midsized PCA are affected by the method of overhead allocation. The last three columns in Table 4 indicate the amount of PCA operating expense (overhead plus allocable operating expense) each member would pay (per unit volume) under the three alternative methods of allocating overhead expense. Variations in charges per unit volume are mainly due to differences in the allocable costs of serving members of different size and credit quality—not to the method of overhead allocation. In this case, the method of overhead allocation would likely be far less controversial than the basic idea of differentiation based on customer cost.[8]

Provision for loan loss expense should ideally be allocated among members according to the actuarial expected value of loan losses for each customer. It may be accomplished with prepaid insurance or risk premiums added to the spreads. Premiums would likely reflect enterprise, location, and financial risk of customers. Much theoretical and empirical work remains to be done in order to identify actuarially fair premiums.

Finally, there are parallels between the question of how the burden of contributing to the net income of the association should be distributed and the issue of overhead allocation. Some argue that each member should contribute an equal amount of net income (Knutson), while others imply that contributions to net income should be in proportion to volume (Phillips). The issue would not be controversial if the association operated on a nonprofit basis (either purposely pricing to break even, or, allocating its net income to members via ex post patronage refunds). Principles of cooperation offer little concrete guidance regarding which members should contribute to income.

We offer some pragmatic guidance as to how income could possibly be increased.

[8]In other cases where overhead is large in relation to operating expenses, the method of overhead allocation could be quite controversial.

Table 3. Operating Expense Structure for Hypothetical Small, Medium, and Large PCAs[a]

PCA	Hypothetical PCA Characteristics: Volume (V)	Members (N)	Spec. Credit Volume (SV)	Predicted Operating Expenses: Allocable[b]	Overhead ($\hat{O}$)	Total ($\hat{EXP}$)	Overhead as Percent of Total	Total Per Member ($\hat{EXP}/N$)	Total Per Unit Volume ($\hat{EXP}/V$)
	(000)		(000)	(000)	(000)	(000)			
I	$40,000	788	$16,380	$1,018.2	$137.5	$1,155.7	11.9%	$1466	$28.89
II	80,000	1,577	32,760	2,036.4	137.5	2,173.9	6.3	1379	27.17
III	120,000	2,365	49,141	3,054.5	137.5	3,192.0	4.3	1350	26.60

[a]For purposes of this table, PCA member unit volume (NV) equals the sample mean, .019709, and the proportion of special credit volume (SV/V) equals the sample mean for this ratio, .409506.

[b]Allocable expense $= \hat{a} \cdot N + \hat{b} \cdot V + \hat{c} \cdot SV$

First, small PCAs should consider merging to capture available economies of size. Merger of two $40 million PCAs could reduce operating expense by 17 basis points according to our estimates—a total annual savings of $136,000. Second, PCAs should adopt differential pricing based on size and credit quality. Our analysis shows that price differentiation would be consistent with providing service at cost. Economic theory suggests that price differentiation might also enhance net income. That is particularly true where the market has already been segmented by competitors based on customer size and credit quality. In a differentiated market, failure of PCAs to differentiate will result in continued exit of low-unit-cost members. That drives up unit costs of serving remaining members and makes the task of income generation and equity restoration even more difficult.

Table 4. Allocable Operating Expense for Hypothetical Customers with Different Size and Credit Quality Characteristics

Member Volume (v)	Allocable[a] Expense (exp)	Average Allocable Expense (ae)
(000)		
	Regular Credit ($s = 0$):	
$ 20	$ 774	$38.71
50	1,108	22.17
100	1,665	16.65
250	3,335	13.34
	Special Credit ($s = 1$):	
$ 20	$ 943	$47.13
50	1,529	30.59
100	2,507	25.07
250	5,440	21.76

[a]$exp = \hat{a} + \hat{b} \cdot v + \hat{c} \cdot s \cdot v$
$= 551.58 + 11.135 \cdot v + 8.42 \cdot s \cdot v$

Summary and Conclusions

This paper has advanced the *differential pricing* interpretation of the cooperative principle of service at cost. Under this interpretation, costs are borne by members in proportion to their contribution to the expenses of the cooperative not in proportion to their volume of patronage. Adherence to this interpretation requires knowledge of the costs of serving individual members. A method was developed for identifying costs of serving individual PCA customers. Underlying the methodology was a model in which (a) allocable operating expense of serving individual members depends on member volume and other member characteristics, and (b) total operating expense for the PCA equals the sum of the expenses allocable to individual customers plus overhead. Parameters of the individual member allocable expense equation appear in the PCA operating expense equation. The operating expense equation was estimated by GLS from cross-sectional data. Per unit costs of serving PCA customers were found to vary directly with credit quality and inversely with customer volume. The results provide a strong rationale for differential pricing by PCAs under our interpretation of the principle of service at cost. Other pricing issues that were discussed included: pricing to recover overhead, cost of funds, provision for loan loss, and contributions to net income.

Cooperatives may be forced by competitive circumstances into more widespread

Table 5. Impact of Overhead Allocation Method on Various Members of a Hypothetical Midsized PCA II[a]

Member Volume (v)	Member Allocable Expense: Total (exp)	Member Allocable Expense: Per Unit Volume (ae)	Overhead Allocated to Member Per Unit Volume[b]: Method A	Overhead Allocated to Member Per Unit Volume[b]: Method B	Overhead Allocated to Member Per Unit Volume[b]: Method C	Operating Expense Imputed to Member (Overhead Plus Allocable Expense) Per Unit Volume: Method A	Operating Expense Imputed to Member (Overhead Plus Allocable Expense) Per Unit Volume: Method B	Operating Expense Imputed to Member (Overhead Plus Allocable Expense) Per Unit Volume: Method C
(000)								
Regular Credit								
$ 20	$ 774	$38.71	$4.36	$1.72	$2.61	$43.08	$40.43	$41.33
50	1,108	22.17	1.74	1.72	1.50	23.91	23.89	23.66
100	1,665	16.65	0.87	1.72	1.12	17.52	18.37	17.78
250	3,335	13.34	0.35	1.72	0.90	13.69	15.06	14.24
Special Credit								
$ 20	943	$47.13	$4.36	$1.72	$3.18	$51.50	$48.85	$50.32
50	1,529	30.59	1.74	1.72	2.07	32.33	32.31	32.65
100	2,507	25.07	0.87	1.72	1.69	25.94	26.79	26.76
250	5,440	21.76	0.35	1.72	1.47	22.11	23.48	23.23

[a]See Table 2 for characteristics of PCA II.

[b]Method A: Equal amount per member, member's share is $\hat{O} \cdot N$.
Method B: In proportion to volume, member's share is $v \cdot \hat{O} \cdot V$.
Method C: In proportion to member's share of allocable PCA expense, member's share is $\hat{O} \cdot exp \cdot (EXP \cdot \hat{O})$.

adoption of differential pricing. Failure of cooperatives to do so provides competitors an opportunity to target the best (lowest unit cost) customers (i.e., to "cherry pick"). As the low-unit-cost members are "picked" by competitors, the cooperative loses advantages of economies of size, and remaining members must bear higher unit costs. If PCAs are to respond to the problem, they should consider adopting differential pricing. In our view, differential pricing based on cost of serving customers is consistent with cooperative principles.

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Farm Viability Revisited: A Simultaneous-Equation Cash Flow Approach

Adesoji O. Adelaja and Karen B. Rose

Abstract

A simultaneous-equation cash flow (SECF) model was used to evaluate the sources of short-run economic viability for farm households. Due to its simultaneity the model provided a better approximation of the financial behavior of farmers and more explanatory power than previously used single-equation models.

Empirical findings for a group of farm households in southern New Jersey suggested that economic viability is positively related to size, gross farm income, off-farm income, operator's education and experience, and the number of adult family members, but it is inversely related to debt and the age of the operator. Tree fruit farms were the most economically viable and grain farms the least. Off-farm income was important to farm households because it was used to retire debt and, thus, to reduce financial stress.

Key words: economic viability, cash-flow, off-farm income, simultaneous-equation model, farm debt.

In response to the increased financial stress and the relatively high rates of insolvency and failure among U.S. farms in recent years, there has been renewed interest among agricultural economists in studying the causes of financial stress in agriculture (Shepard and Collins; Lines and Morehart; Lines and Zulauf; Wickens). A number of studies on the subject identified and estimated the relationships between short-run economic viability of farms (the ability of farm households to meet their financial obligations),[1] and its determinants (Jolly and Doye; Johnson et al.; Smale et al.; and Salant et al.). The justification for estimating such relationships is that information on the nature and relative importance of factors contributing to economic viability can be useful in identifying farms facing financial stress and the reasons why they are experiencing such stress.

The general approach in past studies has been to develop measures or proxies for economic viability and to estimate, based on single-equation linear models, the relationships between such measures and their determinants. The measures used in the past as proxies for the dependent variable, economic viability, include the debt-to-asset ratio, the viability ratio, and cash flow. Among the included explanatory variables were measures descriptive of operator characteristics such as age, years of experience, and years of schooling; measures descriptive of farm business characteristics such as gross sales, farm size, profitability, debt-to-asset ratio, and

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[1]Financial obligations include farm production costs, debt obligations, and family living expenses.

type of farming operation; and measures of other characteristics such as hours of off-farm employment, off-farm income, household size, and number of adults in the farm household. Many of the estimated coefficients were insignificant, but in general, age, size, off-farm income, operator years of education, and the number of adult household members were directly related to economic viability, while debt-to-asset ratio, operator experience, and family size were inversely related to economic viability. The observed inverse relationship between experience and economic viability seems rather irrational. Furthermore, the fact that many of the coefficients estimated in previous studies were insignificant suggests that some of the models may have been inappropriately specified.

Several inherent flaws of previously used viability models, which may make them unreliable as predictors of short-run economic viability, are apparent. First, the choices of some of the proxies for economic viability are questionable as the proxies do not always correctly indicate short-run economic viability. This implies that problems associated with errors in variables may be inherent in estimates derived in previous studies. Thus, previous models can lead to erroneous predictions of whether a farm, given its characteristics, is economically viable in the short run. Second, some of the relationships expressed in the form of single-equation models in past studies appear to be simultaneous in nature. Previous models, therefore, may be incorrectly specified, and previous parameter estimates may be biased as a result of specification error.

This paper reexamines the sources of financial stress in agriculture. The specific objectives are threefold: (*a*) to review and critique approaches that have been used in the past to explain short-run economic viability on the basis of variable measurement, specification, and predictability, (*b*) to specify and estimate an alternative model that more nearly approximates the determination of economic viability of farm households in the short run, and (*c*) to compare the ability of past models to predict financial stress with that of the alternative model.

A Brief Critique of Economic Viability Models

Previous studies that used the debt-to-asset ratio as the proxy for short-run economic viability considered farm households with debt-to-asset ratios of less than 40 percent to be in good financial health and to be relatively free of financial stress (Benjamin; Lee; Johnson et al.; Jolly and Doye). Farms with debt-to-asset ratios of over 40 percent, however, were considered to be experiencing some form of financial stress. The argument forwarded for the 40 percent threshold was that farms with more than 40 percent debt-to-asset ratio tended to face difficulties in meeting annual interest and principal payments on their debt.[2] Jolly and Doye reported a debt-to-asset ratio of 26 percent on the average for U.S. farms and concluded that 17 percent of U.S. farms were experiencing financial stress in 1985.

Several limitations of the debt-to-asset ratio approach are apparent. First, debt-to-asset ratio may not always be a good indicator of economic viability. Because economic viability is technically defined as a farm's ability to meet its financial obligations in the short run, a direct measure, such as cash flow (gross farm income minus financial obligations), seems more appropriate. An extremely high debt-to-asset ratio does not necessarily imply economic nonviability. For example, many commercial farms that are heavily mortgaged and, thus, have high debt-to-asset ratios may be able to meet their financial obligations and to generate positive cash flow. Those farms may be viable. Besides, in looking at the farm household as the unit of analysis, debt-to-asset ratio as a measure of economic viability breaks down if one considers the fact that it is conceivable for a heavily mortgaged farm to be economically viable if sufficient off-farm income is generated and used to support the farm. Debt-to-asset ratio appears to be a determinant of economic viability rather than a measure of it. This suggests the possibility of errors in the dependent variable and, thus, specification errors.

[2]A debt-to-asset ratio of 100 percent represents absolute insolvency.

Another limitation of the debt-to-asset ratio approach is that the choice of 40 percent as the threshold value for economic viability seems rather arbitrary. The threshold value is subject to change if factors such as average length of loan obligations (short term, medium term, or long term) and interest rates change. At higher interest rates, the threshold value decreases because financial obligations increase. Hence, marginally viable farms may no longer be viable. To make debt-to-asset ratio as efficacious as cash flow as a measure of economic viability, it must be made flexible enough to incorporate information on interest rates and average duration of debt (see Appendix A).

The viability ratio (*VR*), which is the ratio of net household income to financial obligations, is the proxy for economic viability used by Smale et al. The financial obligations included operating costs, principal and interest payments on debt, minimum level of family consumption expenses,[3] taxes, and capital replacement costs. Johnson et al., on the other hand, used cash flow (*CF*) as the proxy for economic viability and measured it as the total net income minus financial obligations.[4] The difference between *VR* and *CF* is that *CF* is measured in absolute terms, while *VR* is scaled such that $CF = 0$ implies that $VR = 1$, $CF < 0$ implies that $VR < 1$, and $CF > 0$ implies that $VR > 1$.[5] Because it is scaled, *VR* presumes that small farms with viability ratios equal to but cash flows lower than large farms are equally viable. However, evidence from past studies suggests that economic viability is directly related to farm size (Lines and Morehart; Lines and Zulauf).

Although both *CF* and *VR* provide similar measures of economic viability, *CF* may be preferred to *VR* because it measures economic viability in actual dollar terms or in units that can be easily understood by farmers, researchers, and policy makers. Besides, using *CF* as the dependent variable allows the measurement of the impacts of determinants of economic viability in actual dollar terms. A problem with both the *CF* and *VR* measures, however, is that they are contingent on the farmer's subjective measure of depreciation. For example, two farms that are equally viable may report different cash flows or viability ratios if they use different depreciation schedules.

Conceptual Framework and Economic Model

The methodology employed in this study involves the use of a simultaneous-equation cash flow model to examine the sources of short-run economic viability. A cash flow model was used because it has advantages over the debt-to-asset ratio and the viability ratio models. Because our purpose was to identify the determinants of short-run economic viability and to estimate the impact of each determinant on viability, the model was specified to account for all variables included in previous models. Furthermore, instead of a single-equation model, a simultaneous-equation model was specified because such specification more nearly approximates farm household cash flow behavior.

Cash flow has two basic components: household cash income and household financial obligations. The first component includes gross farm income (*GFI*) and off-farm income (*OFI*). The second component includes principal and interest payments on debt (*PIPD*), other production expenses (*OPE*), and other financial obligations (*OFO*). Assuming that *PIPD* is proportional to total debt (*DT*), *DT* can be used as a proxy for *PIPD*. Similarly, profitability ratio (*PR*), which is the ratio of

[3] Minimum level of family consumption expenses is defined as the cost of providing a nutritionally adequate diet, plus the cost of other basic household needs such as housing, clothing, and medication (see Smale et al. for a full definition of family consumption expenses).

[4] A farm household is considered to be economically viable if $CF \geq 0$ or $VR \geq 1$.

[5] Given that $VR = I/F$ and $CF = I - F$ where I and F are, respectively, net income and total financial obligations, the following can be obtained:

$$(a)\ CF/F = (I-F)/F = (I/F) - 1 = VR - 1.$$

Thus,

$$(b)\ CF = F(VR - 1).$$

It can be seen from equation b that if $VR = 1$, then $CF = 0$; if $VR > 1$, then $CF > 0$; and if $VR < 1$, then $CF < 0$. Furthermore, if $VR = 1$, $lnVR = 0 = CF = VR - 1$. Therefore, for marginally viable or nonviable farms ($VR = 1$, $CF = 0$), $0 - CF = 1 - VR$, and both measures deviate from the critical value by similar values.

net farm income (after taxes and interest payments) to gross farm income, can serve as a proxy for *OPE* and *OFO* (as *OPE* and *OFO* increase—incomes remaining constant—*PR* is expected to decrease). The basic cash flow relationship can thus be expressed as

$$CF = CF(GFI, OFI, DT, PR). \quad (1)$$

Equation 1 is similar to equations specified in previous studies in that it includes measures of size (*GFI*), off-farm income (*OFI*), indebtness (*DT*), and profitability (*PR*). The literature strongly suggests the inclusion of all those variables in economic viability models (Smale et al.; Salant et al.; Johnson et al.; Ahearn; and Huffman).

In previous studies, other farm variables were included as explanatory variables on the right-hand side of equation 1. However, those variables are more likely to be determinants of the explanatory variables listed in (1). For example, *GFI* is a function of the output of the farm, which in turn is a function of the size of physical resources. Because farm acreage is a major indicator of farm size, it can be said to be a determinant of *GFI*. Shepard and Collins demonstrated that farm size or scale is a determinant of economic viability, while Lines and Morehart indicated that economic viability is affected by type of commodity produced. Furthermore, the relationship between output, or *GFI*, and acreage is likely to depend on the type of commodity produced. Hence, a *GFI* equation is expressed as

$$GFI = GFI(AC, D), \quad (2)$$

where *AC* is farm acreage, which is a proxy for farm size, and *D* is a dummy variable vector for type of farming activity.

Because assets are used as collateral for debt, debt can be assumed to be positively related to farm size. Smale et al. showed that a major indicator of farm size is the value of assets. Smale et al. and Lines and Zulauf also showed that off-farm income is a major determinant of economic viability. We hypothesize that this is due to the fact that off-farm income contributes to cash flow directly—as indicated in (1)—and that off-farm income is a means by which farm debt can be more rapidly retired. Other sources of income such as revenues from asset sales can also be used to retire debt. Thus, a farm debt equation is expressed as

$$DT = DT(A, OFI, RAS), \quad (3)$$

where *A* is total farm and personal assets and *RAS* is revenue from asset sales. The inclusion of revenue from land sales (*RS*), which is a component of *RAS*, as an explanatory variable is particularly relevant in areas where significant land sale opportunities exist.

Decisions to work off the farm by a farm operator, his spouse, or his children are affected by the family's ability to supply labor to the nonfarm sector. Sumner and Streeter and Saupe showed that such ability depends on educational achievement of the farm family (the higher the education, the better the employment opportunity faced). Ashenfelter and Johnson, Malkiel and Malkiel, and Mincer showed similar relationships for incomes in general. Smale et al. also showed that farm and off-farm incomes increase with the number of family members that are legally eligible to work. Indebtedness is also hypothesized to affect off-farm labor supply decisions. O'Brian and Hawley showed that in the case of women, family debt is directly linked to labor supply and thus income.

The type of farming activity in which the family is engaged is also hypothesized to affect off-farm income. Rose showed that grain farmers tend to have higher off-farm income. On the basis of the evidence on off-farm income, the following off-farm income relationship is assumed:

$$OFI = OFI(ED, NH, DT, D), \quad (4)$$

where *ED* is operator's year of formal education and *NH* is number of household members sixteen years of age or older. The rationale for including *NH* is that even though some adult household members may not have a stake in the farm, they contribute to the viability of the farm by being able to earn income off the farm and by reducing the extent to which farm income is used to support the family. The age of sixteen was chosen as the threshold level following Smale et al.

Personal characteristics of farm operators appear to affect cash flow indirectly by

affecting efficiency and profitability (Krause and Williams). Those variables are assumed to impact on *PR*. In specifying a *PR* function, it is important to note that farming activities may vary in their degree of profitability and that profitability may vary with farm size. Age should also be directly related to profitability as older farmers tend to have lower debt, lower interest payments, and higher net farm income. Experience can also be expected to vary directly with profitability. The profitability function is thus specified as

$$PR = PR(AGE, EXP, ED, GFI, D), \quad (5)$$

where *AGE* represents the age of the farm operator and *EXP* represents the operator's years of experience. *GFI* is used as a proxy for farm size in Equation 5.

Land assets are a major component of all farm assets, ceteris paribus, total farm assets should be directly related to farm acreage. Furthermore, the relationship between assets and acreage is expected to depend on the type of farming operation. Assuming the type of operation to be an intercept shifter in the asset-acreage function, the function is expressed as

$$A = A(AC, D). \quad (6)$$

Finally, an acreage equation can be specified as

$$AC = AC(D). \quad (7)^6$$

Equations 1–7 represent a system of simultaneous equations. The estimation of all seven equations as a system should generate more efficient estimates of farm cash flow behavior than the estimation of a single-equation model because it would account for simultaneity in farm cash flow behavior. Previous studies estimated a modified version of equation 1 by including variables such as *AGE, EXP, D, NH, RAS, A,* and *AC* among the exogenous variables. As suggested above such specification implies specification error and, thus, biased and inefficient parameters estimates.

Econometric Model

To facilitate econometric estimation of the system of equations represented by equations 1–7, the following linear equations were specified:

$$CF = \alpha_0 + \alpha_1 GFI + \alpha_2 OFI + \alpha_3 DT + \alpha_4 PR, \quad (8)$$

$$GFI = \beta_0 + \beta_1 AC + \beta_2 D_F + \beta_3 D_V, \quad (9)$$

$$OFI = \epsilon_0 + \epsilon_1 ED + \epsilon_2 NH + \epsilon_3 DT + \epsilon_4 D_F + \epsilon_5 D_V, \quad (10)$$

$$DT = \lambda_0 + \lambda_1 A + \lambda_2 OFI + \lambda_3 RAS, \quad (11)^7$$

$$PR = \phi_0 + \phi_1 AGE + \phi_2 (EXP)^2 + \phi_3 ED + \phi_4 GFI + \phi_5 D_F + \phi_6 D_V, \quad (12)^8$$

$$A = \pi_0 + \pi_1 AC + \pi_2 D_F + \pi_3 D_V, \quad (13)$$

$$AC = \gamma_0 + \gamma_1 D_F + \gamma_2 D_V. \quad (14)$$

A linear functional form was assumed in order to reduce the complexity of the model. In equations 8–14, D_F and D_V represent dummy variables for type of farming activity. The variables are defined as follows: $D_F = 1$ if the primary activity is fruit production, otherwise $D_F = 0$. $D_V = 1$ if the primary activity is vegetable production, otherwise $D_V = 0$. For grain farms, $D_F = D_V = 0$. It should be noted that while equation 14 is similar to an identity, its inclusion in the system of equations to be estimated permits the measurement of the relative sizes of grain farms, vis-à-vis fruit and vegetable farms.

[6]Equation 6 is included in the system of equations to facilitate the determination of the relationship between asset value and acreage because asset value is more likely to be endogenous than exogenous. Equation 7 is included to facilitate the measurement of the impact of type of enterprise on size or farm acreage.

[7]Rose has shown that revenues from land sales are a significant source of income for farms on the urban fringe. Capital gains from land sales are among the reasons why farmers at the urban fringe have been able to maintain their viability (Lopez et al.) There were inadequate data on revenues from the sale of all assets. Thus, among the revenues from asset sales variables, only revenues from land sales (*RS*) is included as an exogenous variable in equation 4.

[8]$(EXP)^2$ rather than *EXP* was used as an independent variable because past studies have shown that the relationship between experience and income is more nearly monotonic.

To facilitate the comparison of the estimates of the SECF model with those of single-equation models similar to those estimated in previous studies, three more equations were specified and estimated. Those included a single-equation cash flow (CF) model specified as

$$CF = CF(GFI, OFI, DT, PR, AC, D_F, D_V, ED, NH, RS, A, AGE, (EXP)^2), \quad (15)$$

a single-equation viability ratio, (VR) model specified as

$$VR = VR(GFI, OFI, DT, PR, AC, D_F, D_V, ED, NH, RS, A, AGE, (EXP)^2), \quad (16)$$

and a single-equation debt-to-asset ratio (DA) model specified as

$$DA = DT(GFI, OFI, DT, PR, AC, D_F, D_V, ED, NH, RS, A, AGE, (EXP)^2). \quad (17)$$

Equations 15–17 were also estimated as linear functions, following the convention used in previous studies and that used in equations 8–14.

Data and Estimation Technique

The data used in this analysis were compiled from a survey of farms in southern New Jersey conducted by Karen Rose and Donn Derr. The sample was drawn from the New Jersey Motor Vehicle Farmer Certificate data bank. It identifies farmers with registered farm vehicles in the state. In selecting the farms surveyed, minimum acreage criteria were set. Only fruit and vegetable farms operating more than ten acres and grain farms operating more than fifty acres were surveyed because it was established that those threshold levels represented similar gross annual returns. Of the 174 farmers surveyed, only 162 provided complete information. Thus, the final sample used in this analysis included 162 farms: thirty-seven grain farms, thirty-six fruit farms, and eighty-nine vegetable farms. The distribution of the sample by type of activity closely followed the actual distribution of the population.

The survey was designed to generate data on not only the finances of the farm but also the entire farm household. It included data on (*a*) physical resources (size and land use); (*b*) gross farm income from product sales; (*c*) other farm income received (government payments, net farm rent received, dividends received, custom work receipts, tax refunds, recreational income, income from the sale of all assets including land, and income from wood products and farm stand sales); (*d*) cash farm expenses (expenses on labor, repairs, maintenance, interest, rent, feed, seed, market containers, fertilizer, lime, chemicals, custom work, fuel, utilities, taxes, insurance, and other cash business operating expenses); (*e*) estimates of farm asset values (real estate, equipment, trucks, cars, and inventory on hand); (*f*) personal assets (cash, stocks and bonds, and nonfarm real estate); (*g*) all farm and family financial debt (amount, interest rate, type of debt—short, intermediate, and long term—and how secured); (*h*) on-farm employment (hours and wages for all household members); (*i*) off-farm employment (hours and wages for all household members); (*j*) unearned income (social security, veterans' benefits, public assistance, welfare benefits, aid to families with dependent children, unemployment compensation, net nonfarm rent, interest, and dividends); (*k*) changes in farm operations 1979–84 (land transactions—acres and prices—capital investments, the number of new buildings, changes in acres rented and acres operated); (*l*) future business plans; and (*m*) constraints faced in farming. The accounting period was January 1, 1984, to December 31, 1984.[9,10]

From the information obtained, the following data were generated. Gross farm income (*GFI*) was measured as income from all farm sources including income from the sale of assets. Off-farm income (*OFI*) was

[9]Because the accounting period was only one year, the results of this study are more indicative of short-term rather than long-term economic viability. A wide variety of variables were included in the model in order to fully account for economic viability.

[10]In the case of acreage, debt, and asset values, respondents were asked to provide beginning and ending period values.

measured as incomes from wages, self-employment, and unearned income. Annual financial obligations (*FO*) were measured as the sum of income taxes, family consumption, principal and interest payments on debt, production expenses, and capital replacement cost. In calculating the annual financial obligations, federal income taxes, household living expenses, capital replacement costs, and principal payments on debts first had to be estimated (see Rose for details of those calculations). Cash flow (*CF*) was calculated as *GFI* − *FO*. Debt (*DT*) was calculated as all personal and farm debt (short, intermediate, and long term) while assets (*A*) were measured as the value of all land, buildings, machinery, equipment, cars, trucks, inventory, other farm assets, and personal household assets (money held in bank accounts, stocks, bonds, mutual fund shares, other financial instruments, and other nonfarm real estate). In calculating stock type variables such as debt, value of assets and acreage, the beginning and ending period values were averaged. Dummy variables for fruit and vegetable farms were also constructed (for details on the construction of the variables, see Rose).

To facilitate comparison of the estimates derived via equations 8–14 with those obtained via equations 15–17, two more variables were constructed. Debt-to-asset ratio (*DA*) was simply measured as total debt divided by total assets, while the viability ratio (*VR*) was measured as (*GFI* + *OFI*)/*FO*.

Error terms were added to equations 8–14 to achieve stochasticity. The terms were assumed to be independently and normally distributed with zero means and constant variances. Each of the equations in the system was overidentified by the order condition. Each, however, was just identified by the rank condition. In order to obtain consistent parameter estimates, the three stage least squares estimation technique was used to estimate the model. Three stage least squares estimates are more efficient than ordinary least squares (OLS) or two stage least squares estimates when some equations are overidentified (Pindyck and Rubinfeld). The OLS estimation technique was used to estimate equations 15–17.

Empirical Results

Single equation viability models. As stated above, equations 15–17 were estimated in order to determine the performance of models similar to those used in previous studies but using New Jersey data. The parameter estimates of those models are presented in Table 1. As shown in Table 1, the parameter estimates

Table 1. Parameter Estimates of the Single-Equation Models

	Dependent Variables[a]					
	CF		VR		DA	
Explanatory Variables	Parameter Estimate	Standard Error[b]	Parameter Estimate	Standard Error	Parameter Estimate	Standard Error
Intercept	−21436.241	22926.936	0.8979183	0.5645371	51.1295998	10.3356753*
GFI	0.160	0.021*	0.0000016	0.0000005*	−0.0000011	0.0000093
OFI	0.613	0.188*	0.0000249	0.0000046*	−0.0000702	0.0000847
DT	−0.416	0.022*	−0.0000035	0.0000005*	0.0001166	0.0000101*
PR	5048.737	2304.392*	0.1906083	0.0567418*	0.3028832	1.0388413
AC	−37.831	18.706*	−0.0010478	0.0004606*	0.0096625	0.0084331
D_F	−18129.481	9182.342**	−0.0904214	0.2260997	3.4585838	4.1394854
D_V	−10169.532	7157.625**	−0.0093950	0.1762444	−2.3349982	3.2267340
ED	1658.661	1172.909	−0.0013768	0.0028881	−0.8596502	0.5287582
NH	−1386.893	2434.928	−0.1260302	0.0599560*	1.2663504	1.0976883
RS	−0.019	0.035	−0.0000009	0.0000008	−0.0000003	0.0000162
A	0.012	0.006*	0.0000001	0.0000001	−0.0000133	0.0000026*
AGE	323.222	358.738	0.0103489	0.0088333	−0.6762379	0.1617223*
$(EXP)^2$	−1.789	3.982	0.0000740	0.0000980	0.0014994	0.0017950
Adj R^2	0.715		0.432		0.58	
DW Stat	1.976		1.874		2.093	
Kolmogorov-Smirnoff Stat	0.1299		0.0826		0.1588	

[a]OLS estimates.

[b]Single asterisk implies significance at the $\alpha = .05$ level, double asterisk implies significance at the $\alpha = .10$ level.

for *GFI, OFI, DT,* and *PR* are significant in the CF and VR equations. They also have the expected signs (*GFI, OFI,* and *PR* are positively related to economic viability, while *DT* is inversely related). In the DA equation, however, the coefficients (with the exception of the coefficient for debt) are insignificant. This implies that both the VR and CF equations more significantly explain economic viability than the DA equation. In fact, only a few parameter estimates (estimates for *DT, A,* and *AGE*) are significant in the DA model. The inadequacy of the DA equation is further explained by looking at the results of the Kolmogorov-Smirnoff test of normality of the error term. The test yielded a test statistic of 0.1588 for the DA equation suggesting the rejection of the null hypothesis that the distribution of the error term is normal. Nonnormality in the distribution of the error term could have occurred as a result of autocorrelation, heteroscedasticity, misspecification, or errors in variables. Misspecification is most likely the case given the type of data used.

On comparing the CF with the VR model, it is obvious that the CF model outperforms the VR model. The coefficients of D_F and D_V were significant at the 10 percent level in the CF model but not in the VR model. This suggests that the VR model, unlike the CF model, cannot detect differentials in viability or cash positions due to differences in type of enterprise. From this standpoint, the CF model may be preferred to the VR model. The relatively higher R^2 measure for the CF equation (for the CF and VR equations, respectively, R^2 measures were 0.715 and 0.432) further suggests that the CF equation performs better in modeling economic viability. In other words, variables normally considered to be explanatory variables for economic viability explain cash flow better than viability ratio. Thus, the CF model better explains economic viability.

On further comparison of the CF and VR models, it is easily observed that several explanatory variables such as *ED, RS, AGE,* and $(EXP)^2$ are insignificant in both models. The insignificance of the variables that are considered to be causes of viability differentials may suggest that CF and VR, or single-equation viability models in general, may be inappropriate. The Kolmogorov-Smirnoff statistics for the CF and VR models also suggest nonormality. This suggests that autocorrelation, heteroscedasticity, or specification error may also be a problem with single-equation CF and VR models.

In general, results of the single-equation viability models suggest that the models, in general, lack complete explanatory power and may be subject to specification errors. The results also suggest that the single-equation CF model is better at explaining economic viability and that the VR model does not explain differentials in viability between producers of various commodities. In the next subsection, the results of the SECF model are examined.

The SECF model. The parameter estimates of the SECF model are presented in Table 2. The R^2 measure for the system is 0.83, which is higher than the measures for the single-equation models. About 76 percent of the coefficients (twenty-five out of thirty-three were significant at the 10 percent level while about 73 percent were significant at the 5 percent level (one coefficient was significant at the 10 percent level but not at the 5 percent level). Of the eight insignificant coefficients, four were intercept coefficients. The four insignificant slope coefficients were: (*a*) the *RS* coefficient in the DT equation, (*b*) the *ED* coefficient in the PR equation, (*c*) the fruit dummy coefficient in the PR equation, and (*d*) the vegetable dummy coefficient in the PR equation.

All of the slope coefficients in the CF equation were significant at the 5 percent level. Gross farm income was found to be positively related to cash flow and, thus, economic viability (one dollar increase in gross farm income results in a fourteen cent increase in cash flow, or eighty-six cents out of every dollar of revenue is used to meet debt obligations, production, and other expenses, while a residual of fourteen cents goes towards profit). Off-farm income was also found to be positively related to cash flow (sixty-nine cents of every one dollar increase in off-farm income goes towards cash flow, while thirty-one cents goes towards meeting operational expenses, off-farm income tax, and family expenses). This suggests that off-farm income is an

Table 2. Parameter Estimates of the Simultaneous-Equation Cash Flow Model

Equation	Dependent Variable	Explanatory Variable	Parameter	Parameter Estimate[a]	Standard Error[b]
8	*CF*	Intercept	α_0	1112.9430	3955.7350
		GFI	α_1	0.1458	0.0156*
		OFI	α_2	0.6896	0.1667*
		DT	α_3	−0.4107	0.0211*
		PR	α_4	4259.4360	2116.0070*
9	*GFI*	Intercept	β_0	−79220.3000	25002.7600*
		AC	β_1	601.4797	62.3249*
		D_F	β_2	234160.7000	30184.4300*
		D_V	β_3	167312.8000	25432.5800*
10	*OFI*	Intercept	ϵ_0	6148.1650	6227.0670
		ED	ϵ_1	759.4586	442.2067**
		NH	ϵ_2	2468.6300	954.5635*
		DT	ϵ_3	0.0216	0.0081*
		D_F	ϵ_4	−15088.6000	3942.0590*
		D_V	ϵ_5	−11333.9000	2518.5230*
11	*DT*	Intercept	λ_0	40722.8100	15701.4900*
		A	λ_1	0.0734	0.0174*
		OFI	λ_2	−1.7169	0.6148*
		RS	λ_3	0.0474	0.1253
12	*PR*	Intercept	ϕ_0	0.0145	0.7667
		AGE	ϕ_1	−0.0336	0.0121*
		$(EXP)^2$	ϕ_2	0.0005	0.0001*
		ED	ϕ_3	0.0439	0.0406
		GFI	ϕ_4	0.00008	0.0004*
		D_F	ϕ_5	0.3656	0.2737
		D_V	ϕ_6	0.2920	0.2171
13	*A*	Intercept	π_0	119051.3000	88010.7900
		AC	π_1	1102.4490	219.3691*
		D_F	π_2	460414.1000	106166.9000*
		D_V	π_3	294333.3000	89431.2600*
14	*AC*	Intercept	γ_0	217.0395	25.8231*
		D_F	γ_1	−74.2370	36.4735*
		D_V	γ_2	−85.7850	30.3863*
Weighted R^2 for System	0.8310				
Number of Observations	162				

[a]3SLS estimates.

[b]Single and double asterisks imply, respectively, significance at the $\alpha = .05$ and the $\alpha = .10$ levels.

important source of economic viability for farm households. Farm debt was found to be inversely related to cash flow (for every one dollar increase in debt, cash flow falls by forty-one cents). Profitability was also found to be directly related to cash flow (one percentage point increase in profitability ratio is worth $4,259 to farmers). Overall, the coefficients of the cash flow equation suggest strongly that economic viability is directly related to size, off-farm income, and profitability but inversely related to debt and cost of production. Past studies (Smale et al.) confirm those results.

All the coefficients of the GFI equation were significant at the 5 percent level. Increased farm acreage was found to result in increased gross farm income as the value of the marginal product of an acre of land was estimated to be $601. This implies that larger farms generate more income than smaller farms and may be more viable. The coefficients for the dummy variables in the GFI equation suggest that fruit farms

generate $234,161 more income than grain farms while vegetable farms generate $167,313 more income than grain farms. This supports the notion that vegetable and fruit enterprises use land more intensively and, thus, generate more income.

Each additional year of formal education resulted in a $759 increase in off-farm income per year. This supports the hypothesis that better education improves the employment opportunities as well as the earning capacity of the household (Ashenfelter and Johnson; Mincer; Malkiel and Malkiel). For farm households, this suggests that better education contributes to economic viability. The number of adult household members was also directly related to off-farm income and, thus, economic viability. Each additional adult household member contributed $2,468 to off-farm income. In the OFI equation, debt was directly related to off-farm income. This suggests that debt may be an important reason for off-farm employment. O'Brian and Hawley showed that women's participation in the labor force is higher for families in debt. Off-farm income for fruit farmers and vegetable farmers was estimated at $15,088 less and $11,333 less, respectively, than that of grain farmers. This may suggest that grain farm household members, due to their poor farm income positions, are encouraged to work more off the farm to maintain the economic viability of their households. It may also suggest that grain farmers have greater opportunity to work off the farm because grain farming is less family labor intensive compared with vegetable or fruit farming.

With the exception of the coefficient for *RS*, all of the coefficients in the DT equation were significant at the 5 percent level. The insignificant coefficient for *RS* is inconsistent with a priori expectations. It may suggest that revenues from land sales are not utilized in retiring debt. The value of assets was found to be directly related to household debt. The marginal increase in debt as a result of a dollar increase in assets was seven cents. This implies that larger farms carry more debt.

Increased off-farm income also resulted in lower debt. It was estimated that for every dollar increase in off-farm income, farm debt is reduced by $1.72. It was confirmed that debt increases the likelihood of off-farm employment (an important reason for off-farm employment is heavy debt load). Therefore, the finding that increased off-farm income resulted in lower debt implies that by obtaining off-farm employment, operators of highly leveraged farms were able to reduce their debt burdens.

The estimated relationships between debt and off-farm income need, perhaps, to be explained further because there appears to be a contradiction. On the one hand, in the OFI equation, increased debt results in increased off-farm income. This suggests that farm household members work off the farm to reduce debt. On the other hand, in the DT equation, increased off-farm income results in lower debt. From the standpoint of causality, the results are not contradictory but rather consistent with a priori expectations. A farm family facing high debt burdens is expected to seek off-farm employment to reduce debt. Hence, as debt increases, off-farm income increases. Conversely, a family with high off-farm income is expected to be able to apply some of that income to debt retirement. Hence, as off-farm income increases, debt decreases.

In the PR equation, the coefficients of the dummy variable for fruit and vegetable farms were insignificant even at the 10 percent level. This suggests that fruit and vegetable farms are no more profitable enterprises than are grain farms. As discussed above fruit and vegetable farms, however, generate higher farm incomes and lower off-farm incomes. The overall viability situations of those farms will be examined below.

Age was found to be a significant determinant of profitability. However, the estimated coefficient for age was negative, suggesting that younger farmers tend to run more profitable operations. This may suggest that younger farmers are more likely to adopt cost-saving technologies as they are less rigid in their production decisions. Education did not significantly affect profitability. Experience, however, was directly related to profitability, but the impact was rather marginal. Gross farm

income also was directly related to profitability, suggesting that there may be economies of scale associated with large-scale farming. This finding is supported by Adelaja and Hoque who found that significant scale advantages accrue to large farmers.

The coefficients of equation 13 suggest that there is a strong positive relationship between farm acreage and asset value. The marginal increase in asset value resulting from a one-acre increase in acreage was estimated to be $1,104. Fruit and vegetable farms also had, respectively, $460,414 and $294,333 more in assets than grain farms. The coefficients of equation 14 suggest that, on the average, grain farmers operate 217 acres, fruit farmers operate 143 acres, and vegetable farmers operate 131 acres.

Overall impacts of size and type of enterprise. Because the SECF model is simultaneous, the overall impacts of size and types of commodity grown were evaluated through the coefficients from several of the equations in the model. As regards acreage, it was found that larger farms generate higher gross farm income and carry more debt, therefore the overall impact on cash flow was

$$\frac{dCF}{dAC} = \frac{\partial CF}{\partial GFI} \cdot \frac{\partial GFI}{\partial AC} + \frac{\partial CF}{\partial DT} \cdot \frac{\partial DT}{\partial A} \cdot \frac{\partial A}{\partial AC} = \alpha_1\beta_1 + \alpha_3\lambda_1\pi_1 = 87.70 - 33.23 = 54.46. \quad (15)$$

This suggests that larger farms are also more economically viable. The estimate of $\partial CF/\partial AC$ in the single-equation cash flow model is -37.83. This suggests that biases in the single-equation CF model due to specification error may be negative.

Fruit and vegetable farms were found to have higher gross farm income, lower off-farm income, and higher profitability than grain farms. The net increase in cash flow over grain farms by virtue of being fruit and vegetable farms, respectively, were obtained as

$$\frac{dCF}{dD_F} = \frac{\partial CF}{\partial GFI} \cdot \frac{\partial GFI}{\partial D_F} + \frac{\partial CF}{\partial OFI} \cdot \frac{\partial OFI}{\partial D_F} + \frac{\partial CF}{\partial PR} \cdot \frac{\partial PR}{\partial D_F} + \frac{\partial CF}{\partial DT} \cdot \frac{\partial DT}{\partial A} \cdot \frac{\partial A}{\partial D_F} = \alpha_1\beta_2 + \alpha_2\epsilon_4 + \alpha_4\phi_5 + \alpha_3\lambda_1\pi_2 = 11{,}413.42, \quad (16)$$

and

$$\frac{\partial CF}{\partial D_V} = \frac{\partial CF}{\partial GFI} \cdot \frac{\partial GFI}{\partial D_V} \cdot \frac{\partial CF}{\partial OFI} \cdot \frac{\partial OFI}{\partial D_V} + \frac{\partial CF}{\partial PR} \cdot \frac{\partial PR \partial CF}{\partial D_V \partial DT} \cdot \frac{\partial DT}{\partial A} \cdot \frac{\partial A}{\partial D_V} = \alpha_1\beta_3 + \alpha_2\epsilon_5 + \alpha_4\phi_6 + \alpha_3\lambda_1\pi_3 = 8{,}949.31. \quad (17)$$

These suggest that fruit farms are the most economically viable, followed by vegetable farms, followed by grain farms. This is contrary to the results of the single-equation CF model that suggest that fruit and vegetable farmers are less viable than grain farmers.

Efficacy of the SECF Model

To test the performance of the SECF model, we compared predicted with actual levels of cash flow. Predicted and actual values of cash flow, viability ratio, and debt-to-asset ratio were also computed and compared for the CF, VR, and DA models. The root mean square error (RMSE) criterion was used to compare the models.

RMSE was computed as

$$\text{RMSE} = \sqrt{\frac{1}{n}\sum_{i=1}^{n}\frac{(Y_i^p - Y_i^a)^2}{Y_i^a}}, \quad (18)$$

where n is the number of observations, Y_i^p is the predicted value of the forecasted variable, and Y_i^a is the actual value of the forecasted variable. The calculated RMSEs are presented in Table 3.

As shown in Table 3, the SECF model generates the lowest RMSE. This suggests that it has the highest degree of forecast

Table 3. Root Mean Square Percent Forecast Error (RMSE) for the Single-Equation and Simultaneous-Equation Models

Model	RMSE
Single-Equation CF Model	.0752
Single-Equation VR Model	.0925
Single-Equation DA Model	.1274
SECF Model	.0207

accuracy and supports the hypothesis that the SECF model more nearly approximates cash flow behavior. Within the class of single-equation viability models, the CF model generated the lowest RMSE. The calculated RMSEs suggest that this model is the most accurate, followed by the VR model. The DA model is the least accurate in predicting economic viability.

Concluding Comments

This study argues that cash flow is a better indicator of short-run economic viability than the viability ratio, which, in turn, is a better indicator than the debt-to-asset ratio. The study further suggests that a SECF model is more appropriate in modeling and predicting economic viability than previously used single-equation models. Single-equation models may involve errors due to misspecification and, thus, may lead to biased estimates of the influences of causal variables on economic viability. The SECF model demonstrated that some of the variables—based on results of past studies—that had been considered to be unimportant in the determination of economic viability are, in fact, important.

Some of the results of the SECF model are as follows:

1. Gross farm income is directly related to economic viability
2. Off-farm income is directly related to economic viability
3. Debt is inversely related to economic viability
4. Profitability is directly related to economic viability
5. Farm acreage is directly related to economic viability
6. A reason why members of farm households work off the farm may be to reduce their debt load
7. Fruit and vegetable farms generally tend to be more viable than grain farms and they tend to utilize less land but more total assets
8. Education contributes to off-farm income but does not enhance farm income; overall, it enhances economic viability
9. Age does not contribute to economic viability
10. Experience contributes to economic viability
11. Farm size is directly related to economic viability
12. Revenue from land sales does not appear to influence the debt load of farm households

Findings on the relationships between debt and off-farm income suggest that farmers may be able to enhance their short-run viability by taking on off-farm employment. Whether or not the long-run viability of farms is significantly affected by such off-farm employment is uncertain. The findings also suggest that heavy debt burden is among the reasons why farmers seek off-farm employment. Because they used single-equation models, previous studies were unable to fully explain the relationship between debt and off-farm income.

Findings on the determinants of off-farm income strongly suggest that the ability of the household to generate off-farm income and, thus to improve economic viability, depends on the number of employment-eligible household members and on their educational attainment. The findings also suggest that grain farmers may have more time to devote to off-farm employment. The implication of this is that they may be more capable of making their operations more viable in the short run. Thus, they may have more flexibility with respect to achieving viability.

The SECF model allowed the quantification of the impact of causal variables on viability, at least in terms of cash flow. The coefficients of the model can thus be used to predict the cash flow and, therefore, the viability of farm households, given specific data on causal variables. It is a useful tool in assessing the degree of financial stress farm households face in the short run.

Furthermore, the model could be used in advising farm households on how to enhance their viability. It can also be useful to financial institutions, extension workers, researchers, and policy makers in guiding farm households towards better financial management.

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Appendix A

The economic viability of a farm in time period t (EV_t) is defined as the farm's ability to meet its financial obligations in that time period (FO_t). Thus, a comprehensive measure of economic viability is incomes from all sources (both farm and nonfarm) less total financial obligations. It is expressed as

$$EV_t = GFI_t + OFI_t + OI_t - FO_t, \tag{A1}$$

where GFI_t, OFI_t, and OI_t are, respectively, gross-farm, off-farm, and other farm incomes in time period t. FO_t should include all farm and nonfarm (family) financial obligations as defined in the data section. A closer look at equation (A1) suggests that EV_t is simply the farm family cash flow (CF_t). Thus, the following relationship holds true

$$CF_t = EV_t = GFI_t + OFI_t + OI_t - FO_t. \tag{A2}$$

GFI_t is likely to be directly related to the value of the farm's assets A_t and thus can be expressed as

$$GFI_t = a + b(A_t), \tag{A3}$$

where $b > 0$. Further, OFI_t is likely to be related to a number of exogenous factors such as years of education of operator, type of farm, and so on while OI_t is likely to be related to exogenous factors such as investments outside the farm and government payments. Finally, FO_t can be expressed as the sum of principal and interest payments on debt due during the time period t (PI_t) and other financial obligations in period t (OFO_t), which include production expenses, family expenses, and so forth. The relationship can be expressed as

$$FO_t = PI_t + OFO_t. \tag{A4}$$

Principal and interest payments on debt are a function of debt (D_t), interest rate paid on debt per period (i) and the duration of debt obligations (n). For time period t, principal and interest obligations can thus be expressed as (Barry, Hopkin, and Baker)

$$PI_t = D_t i/[1 - (1 + i)^{-n}]. \tag{A5}$$

Furthermore, OFO_t is likely to be directly related to farm size. Using the size of assets as a proxy for farm size and assuming a linear relationship between farm size and other financial obligations, the following relationship is apparent:

$$OFO_t = c + d(A_t), \tag{A6}$$

where $d < 0$.

Substituting equations A5 and A6 into equation A4, and substituting equations A4 and A3 into equation A2, we obtain:

$$CF_t = K + (b - d)A_t - D_t i[1 - (1 + i)^{-n}]^{-1}, \tag{A7}$$

where $K = a - c + OFI_t + OI_t$.

The relationship between asset and cash flow can be seen by differentiating equation A7 with respect to A_t:

$$\partial CF_t/\partial A_t = b - d. \tag{A8}$$

Equation A8 suggests that farm size can have a positive or negative influence on

cash flow, depending on the relative magnitudes of the impact of assets on gross farm income and other financial obligations. The relationship between cash flow and debt can be seen by differentiating equation (A7) with respect to D_t:

$$\partial CF_t/\partial D_t = i[1 - (1 + i)^{-n}]^{-1} < 0. \quad \text{(A9)}$$

The relationship between cash flow and interest rate can be seen by differentiating equation A7 with respect to i:

$$\partial CF_t/\partial i = D_t [i1 - (1 + i)^{-n-2} n(1 + i)^{-(n+1)} - 1 - (1 + i)^{-n}] < 0. \quad \text{(A10)}$$

Equation A10 suggests that the interest rate is inversely related to cash flow and that cash flow becomes more sensitive to interest rate as interest rate increases.

Financial Stress in Dairy Farming: Evidence from New England

Wayne M. Gineo, Boris E. Bravo-Ureta, and James J. Wadsworth

Abstract

This study examines the financial position of a selected sample of New England dairy farms for the years 1982, 1983, and 1984. Criteria developed by Melichar are used to classify dairy farms according to their financial position. It was found that the financial ratios of Vermont dairy farms were stronger than those of the entire region. The results suggest that smaller farms may be financially weaker than larger farms. The data also show that, for the most part, the New England dairy farms in the sample were not severely stressed in any of the three years analyzed.

Key words: financial performance, dairy farms.

Most analysts of the U.S. farm sector remain concerned about the financial stress facing agricultural producers. Factors contributing to the problem include decreased domestic and export demands, rising real interest rates, changes in the value of the U.S. dollar, overproduction, low farm prices, heavy borrowing in the late 1970s, and declining land and asset values. Financial stress not only affects farmers and their families but also impacts adversely on rural communities, farm input dealers, lending institutions, and the nation's economic structure.

Approximately 20 to 25 percent of the nation's farmers are financially stressed and, according to a study by the *Farm Journal* and the Food and Agricultural Policy Research Institute (FAPRI), 12 to 18 percent of those producers may be forced out of farming in the near future. The study also concluded that approximately $30 billion of outstanding agricultural debt may not be repaid.

While financial stress is a national problem, some regions and types of farmers are experiencing less pressure than others. In New England, land values have not declined as has been the case elsewhere in the country, particularly the Midwest. Further, New England farmers have borrowed less than those in other regions, which suggests that they might be better off than their counterparts in the Midwest and other areas of the country. For instance, FAPRI and Gabriel indicated that producers in the East and the Northeast are in a relatively stronger financial position than producers elsewhere. However, Gabriel's data also indicated that the financial position of the nation's dairy farmers is worse than that of producers of several other agricultural commodities.

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Available evidence makes it difficult to determine whether or not New England dairy farmers are financially stressed. Given that milk receipts account for more than one-third of the region's total farm receipts, it is critically important to clarify the financial picture of New England dairy producers.[1] This work would help deal with the financial stress issue and could also provide insights on forthcoming adjustments in the industry.

This study has two objectives. The first is to describe the aggregate financial conditions of New England dairy farms, and the second is to classify those farms according to their financial performance using Electronic Farm Accounting Program (ELFAC) data for 1982–84.[2]

The remainder of this paper is divided into four sections. The following section briefly reviews research on financial stress and financial conditions in U.S. agriculture. In the second section, the data and procedures used in this study are described. The third section contains a discussion of the results. Finally, a summary and the main conclusions of the paper are presented.

Review of Literature

Several recent studies have focused on the financial condition of U.S. farmers. Melichar considered cash flow, income, and balance sheet data as criteria for comparing farm financial figures from 1971 to 1984. He also used debt-to-asset (DA) ratios, return-on-asset ratios (ROA), and return-on-equity ratios (ROE) to group farmers into the following financial categories: (*a*) good, (*b*) fair, (*c*) stressed, and (*d*) vulnerable. From these financial ratios Melichar concluded that, in 1985, 10 percent of commercial farmers were in a vulnerable financial position, seven percent were stressed, and the remaining 83 percent fell into the fair or good categories.

Melichar also examined overall farm debt and the magnitude of bank loans to farmers in order to assess the agricultural banking outlook. He found that past due and nonperforming loans have been rising since 1980 for both commercial and agricultural banks and that agricultural banks have been recently moving into vulnerable positions. In fact, according to data presented by Lee, forty-four agricultural and rural banks failed in 1983, seventy-seven failed in 1984, and 118 failed in 1985. Moreover, Lee reported that an additional 437 agricultural banks were identified as "problem banks" by the Federal Deposit Insurance Corporation.

A study conducted by FAPRI found that, in 1984, 61 percent of all farms had outstanding operating loans. Ten percent of those farms were not current on their loan payments, suggesting that 6 percent of all farms in the country were experiencing financial stress. Those financial problems may force farmers out of the industry at the rate of 5 percent per year over the next three years. Further, FAPRI indicated that stress is affecting all regions of the U.S. with the central and western regions having the most stress and the eastern and southern areas experiencing the least. Younger farmers (age forty-four or younger) appeared to have the highest DA ratios of all age groups.

The *Farm Journal* and FAPRI studied the farm financial crisis as it relates to the general economy. According to that study, 31 percent of U.S. farmers were experiencing financial stress (DA ratio of more than 40 percent) and were holding $140 billion of the total $211 billion U.S. farm debt. The study concluded that the current farm financial crisis will result in numerous farm loan defaults having direct and indirect adverse effects on the U.S. economy. Direct effects will consist of higher short-term interest rates and higher interest rate risk premiums in the agricultural credit market. Indirect impacts will be in the form of higher unemployment, reduced gross national product, fewer housing starts, lower personal income, and a larger federal deficit.

[1]Dairy farm receipts in 1984, as a percentage of total farm receipts, were 10 percent in Rhode Island, 22 percent in Massachusetts, 24 percent in Maine, 25 percent in Connecticut, 46 percent in New Hampshire, and 78 percent in Vermont. For the region as a whole, the corresponding figure was 37 percent (USDA).

[2]ELFAC is a management educational program for farms designed to improve management and increase earnings. The organization is sponsored by the individual extension services in the northeastern United States.

State-level studies have provided additional insight into the financial stress problem. Scott grouped a sample of Illinois farmers into different categories depending on acreage, tenure status, and soil productivity. The criteria used to determine farm financial soundness were the DA ratio, the interest paid over gross farm returns (IP) ratio, and the coverage ratio (net farm investment income over interest paid). The study showed that 27 percent of Illinois farm families had IP ratios exceeding .2, which, according to Scott, implies negative net farm income. In addition, 32 percent of Illinois farmers were financially stressed with DA ratios over 50 percent. However, many Illinois farmers have developed off-farm income sources that enhance debt servicing ability and probability of survival.

Grisley used residual cash flows to measure the financial stress of Pennsylvania dairy farmers. Residual cash flow (RCF) is defined as the difference between gross returns and operating expenses, interest and principal payments, and inventory adjustments. The farms in the sample were segmented into the following three financial positions: (*a*) severely stressed (zero or negative RCF), (*b*) moderately stressed ($1–$15,000 RCF), and (*c*) sound (RCF is greater than $15,000). Grisley's results suggested that, in 1983, 24 percent of Pennsylvania's dairy farms were severely stressed and 25 percent were moderately stressed.

A study that analyzed debt and interest paid per cow for a sample of Maine dairy farms showed that, in 1985, only 7 percent of the farms were in a high debt per cow classification (greater than $3,000 per cow) and that 86 percent were financed by the Farmers Home Administration (FmHA), which offers relatively low interest rates (Thurston et al.). Overall, the authors concluded that the majority of dairy farmers in Maine were not experiencing serious financial difficulties.

Using a sample of Illinois farmers Lins et al. compared the following three financial stress measures: (*a*) DA ratio, (*b*) the multiple criteria classification developed by Melichar, and (*c*) the multiple classification scheme used by the U.S. Department of Agriculture (USDA). The authors concluded that the DA ratio does not provide an adequate reflection of financial performance in agriculture. They also argued that the multiple criteria system is a better indicator of financial stress; however, studies that use that approach have to be read with caution because such studies can use either a cash-based or an accrual-based definition of income. In their view, the latter is a more accurate measure of income but "data problems often prevent the measurement of accrual income" (Lins et al., p. 60).

In sum, recent literature clearly shows that there are concerns about the farm financial crisis at national, regional, and state levels. Additional research is needed to assess the financial strength of the nation's farmers.

Data and Methodology

The data from ELFAC records for individual farms were used to examine the financial position of New England dairy farms. Incomplete or clearly inaccurate records were deleted from the data, and a total of 149 observations for the years 1982, 1983, and 1984 were used in the analysis. The 149 observations represented the same farms in each of the three years. A problem associated with using ELFAC data is that it does not constitute a random sample of the dairy farm population in New England. As a consequence, it is not possible to make statistically precise inferences to the population. However, the lack of data from a random sample and the high cost that would be associated with collecting such data give little choice as to data selection. Furthermore, as Batte and Sonka recently argued in their study of Illinois grain farms, data emanating from farm record keeping services (such as ELFAC) tend to be more accurate than information collected from a random sample due to supervision by field agents for the service or by individuals in charge of processing the data in central offices. In addition, farm record services provide "observations for a relatively large number of producers for a multiyear period" (Batte and Sonka, p. 602).

For each year the sample was divided according to herd size and sales class to examine the relationship between financial position and farm size. The herd size classes, described below, correspond closely to those used in ELFAC summary

reports, while the sales class categories represent a subset of those typically used by USDA when analyzing farm financial characteristics. Average number of cows per farm was used to divide the sample into the following four herd size classes:

Herd Size Class I: cows $\leq$ 40,
Herd Size Class II: 40 $<$ cows $<$ 60,
Herd Size Class III: 60 $\leq$ cows $<$ 80,
Herd Size Class IV: cows $\geq$ 80.

Based on total gross returns (TGR), defined as the sum of operating receipts plus capital sales, the following three sales classes were used:

Sales Class I: TGR $<$ \$100,000,
Sales Class II: \$100,000 $\leq$ TGR $<$ \$250,000,
Sales Class III: TGR $\geq$ \$250,000.

The methodology employed to classify dairy farms according to their financial performance was developed by Melichar. As shown in Table 1, the criteria are based on a combination of the operator's equity, debt-to-asset ratio, return on assets, and return on equity.

Financial ratios used in this study are defined in the following paragraphs.

ROI is return on investment, or net farm income before interest payments minus the value of unpaid labor as a percentage of total farm investment. Investment is defined as the average value (beginning of year plus end of year divided by two) of land, of buildings and equipment, of livestock, and of supplies in inventory. Net farm income equals total gross returns minus total expenses plus changes in inventory.

Table 1. Criteria Used for Classification of Dairy Farms by Financial Position[a]

If DA Ratio Is	And If Return On Assets Is	And If Return On Equity Is	Then Financial Position Is
	Operators with Equity Under \$50,000		
Under 40	Above 0	na	Good
40 to 70	Above 5	na	Good
Over 70	Above 15	na	Good
Under 40	−5 to 0	na	Fair
40 to 70	0 to 5	na	Fair
Over 70	5 to 15	na	Fair
Under 40	−15 to −5	na	Stressed
40 to 70	−5 to 0	na	Stressed
Over 70	0 to 5	na	Stressed
Under 40	Under −15	na	Vulnerable
40 to 70	Under −5	na	Vulnerable
Over 70	Under 0	na	Vulnerable
	Operators with Equity Above \$50,000		
Under 40	Above 0	Above 0	Good
40 to 70	Above 5	Above 5	Good
Over 70	Above 15	Above 15	Good
	If not already classified as good, then		
Under 10	Above −15	Above −15	Fair
10 to 40	Above −5	Above −5	Fair
40 to 70	Above 0	Above 0	Fair
Over 70	Above 5	Above 5	Fair
	If not already classified as good or fair, then		
Under 10	na	na	Stressed
10 to 40	Above −15	Above −15	Stressed
40 to 70	Above −5	Above −5	Stressed
Over 70	Above 0	Above 0	Stressed
If not already classified as good, fair, or stressed, then financial position is vulnerable.			

na = Not applicable

[a]Criteria developed by Melichar (p. 7).

ROA is return on assets or net farm income before interest payments minus the value of unpaid labor as a percentage of total farm assets. Assets are defined as the end of year value of the same items included in investment plus accounts receivable.

ROE is return on equity or net farm income less unpaid labor and interest payments as a percentage of equity.

E is equity or total farm assets minus total debt.

DA is debt-to-asset ratio or total debt as a percentage of total farm assets.

It should be noted that our definition of net farm income is not on a full accrual basis because depreciation could not be included in the calculations due to data limitations. When depreciation is sizable, its exclusion can have an impact on the measurement of net farm income and financial ratios. To minimize the effect of that common data limitation, Melichar specified relatively high rates of return on assets and equity when developing his classification system. For further details on that issue, the interested reader is referred to Lins et al.

In order to avoid possible distortions caused by outlier observations, individual farm financial ratios (ROA, ROE, ROI, and DA) are weighted by taking the farm's gross returns (TGR) as a percent of the TGR for the entire sample. The weighting method was used when calculating financial ratios by region, herd size, and sales class.

Results

Financial characteristics by region. Table 2 contains a variety of financial measures for the New England region as a whole (excluding Rhode Island), and it lists the same measures for the states of Maine and Vermont, and the south central (SC) New England subregion (Connecticut, Massachusetts, and New Hampshire). The financial measures reported in the table are used to assess the general financial position of New England dairy farms during the three-year period, 1982–84.

Table 2 shows that, over 1982–84, the DA ratio for the 149 dairy farms in the sample declined slightly from 21.7 to 20.6 percent. However, during the same period all rates of return (ROA, ROE, and ROI) decreased. The decline in the DA ratio suggests an improving financial position, but declines in the rates of return reflect a deteriorating financial position.

Financial measures for the two states and the SC subregion are also reported in Table 2. For the SC subregion the DA ratio declined from 23.9 to 21.2 percent during the three-year period, while ROI increased by two percentage points from 1982 to 1984. However, ROA and ROE for the SC subregion decreased during that time. The DA ratio for Maine dairy farms declined slightly (31.6 to 29.4 percent) over the three years. Rates of return on assets, equity, and investment for the Maine farms all decreased by approximately four percentage points. The data appear to indicate that the financial position of Maine dairy farms weakened slightly over the period studied.

The financial position of Vermont dairy farmers also weakened slightly over the time period analyzed. The overall DA ratio remained constant, but rates of return declined for those farms. The largest decline was for the ROI, which dropped by 8.3 percentage points. Intrayear comparisons show that Vermont dairy farmers, for the most part, had stronger financial ratios than did dairy farmers elsewhere in New England during each of the three years. One exception is that the ROE for Maine farms was stronger than for Vermont farms in each year.

In summary, the regional evaluation of aggregate financial ratios indicates that, in general, none of the subregions covered showed signs of significant financial deterioration over 1982–84. A comparison of individual subregions with the entire region shows that Vermont dairy farms may have been financially stronger than those in other regions in all three years.

Financial characteristics by herd size. As indicated earlier, the entire sample was subdivided into four size classes based on the number of cows per farm. Financial characteristics of farms by herd size are reported in Table 3. For Class I the DA ratio declined 9.8 percentage points from 1982 to

Table 2. Financial Characteristics of Selected New England Dairy Farms by Region: 1982–84

	New England			South Central Region (CT, MA, NH)			Maine			Vermont		
	1982	1983	1984	1982	1983	1984	1982	1983	1984	1982	1983	1984
Number of Farms	149	149	149	27	27	27	29	29	29	93	93	93
Cows/ Farm	66	67	66	91	91	91	58	58	58	62	63	62
Total Gross Returns	142,778	155,184	145,849	199,435	206,840	199,323	134,040	142,237	135,143	129,070	144,224	133,663
Gross Rets. (Milk)	136,786	142,241	136,678	191,197	197,384	188,333	128,219	134,686	124,685	123,660	128,588	125,421
Net Farm Income	27,283	26,085	22,569	31,892	28,915	26,678	29,895	34,041	23,797	25,131	22,782	20,993
Assets	321,028	330,111	348,853	378,842	382,490	408,494	342,336	350,755	376,249	297,600	308,473	322,996
Debt	69,300	65,473	70,455	94,687	84,766	88,451	106,969	106,913	113,049	50,183	46,949	51,948
Net Worth	254,878	277,825	279,136	288,685	280,656	329,064	234,972	243,490	260,165	251,271	287,805	270,557
DA Ratio[a]	21.7	20.7	20.6	23.9	22.2	21.2	31.6	30.9	29.4	17.5	17.4	17.5
ROA[b]	11.5	10.0	8.4	11.0	9.8	7.9	11.2	- 10.0	7.1	11.8	10.2	9.1
ROE[c]	12.0	11.8	9.5	11.2	10.8	8.6	15.3	18.4	11.1	11.4	10.1	9.3
Investment	314,220	322,081	341,318	370,224	357,236	379,194	334,636	343,578	371,705	291,595	305,172	320,846
ROI[d]	11.8	10.3	9.9	11.3	10.9	13.3	11.6	10.2	7.4	17.5	17.4	9.2

[a]DA = debt to asset.

[b]ROA = return on assets.

[c]ROE = return on equity.

[d]ROI = return on investment.

Table 3. Financial Characteristics of Selected New England Dairy Farms by Herd Size: 1982–84

	Herd Size Class I[a]			Herd Size Class II[b]			Herd Size Class III[c]			Herd Size Class IV[d]		
	1982	1983	1984	1982	1983	1984	1982	1983	1984	1982	1983	1984
Number of Farms	32	28	31	45	43	42	38	44	42	34	34	34
Cows/ Farm	35	32	33	50	49	49	69	68	68	116	117	117
Total Gross Returns	70,003	104,178	68,060	103,636	103,043	105,472	150,257	150,491	147,888	254,762	269,204	264,134
Gross Rets. (Milk)	67,028	71,696	63,074	98,688	97,087	97,341	144,848	143,966	141,096	243,853	255,213	246,921
Net Farm Income	14,276	12,051	11,576	21,032	23,113	21,313	31,507	29,101	23,086	43,079	37,498	33,505
Assets	187,804	192,903	195,914	248,841	248,009	291,675	352,870	338,144	347,556	506,370	536,548	560,533
Debt	53,307	44,859	36,820	59,551	56,324	66,069	63,616	69,628	69,516	103,606	88,642	107,700
Net Worth	139,339	147,919	163,924	190,976	244,717	223,718	291,899	272,495	277,224	406,822	433,838	455,003
DA Ratio[e]	29.4	21.9	19.6	24.2	21.2	21.1	17.6	23.7	20.3	21.1	17.9	20.7
ROA	11.8	10.1	8.6	11.3	11.1	8.3	12.3	10.6	8.9	11.0	9.1	8.1
ROE	11.2	10.5	8.7	15.1	16.2	13.0	11.7	13.0	10.1	10.9	9.1	7.5
Investment	183,797	191,686	194,202	244,098	244,579	287,763	344,770	337,244	345,123	495,635	507,862	536,909
ROI	12.0	10.3	8.6	11.6	11.3	8.6	12.6	10.0	9.0	11.3	9.9	11.4

[a]Herd Size Class I: ≤40 cows.

[b]Herd Size Class II: >40 but <60 cows.

[c]Herd Size Class III: ≥60 but <80 cows.

[d]Herd Size Class IV: ≥80 cows.

[e]Terms defined in footnote to Table 2.

1984. The DA ratios for Class II and Class IV dropped slightly. However, the DA ratio for Class III increased from 17.6 in 1982 to 20.3 in 1984. With one minor exception, rates of return on assets, equity, and investment declined for each herd class. The only exception is that ROI for Class IV was stable over the sample period.

Within-year comparisons for the herd classes are made by contrasting mean values for each class with those reported in Table 2 for the region. In 1982, DA, ROA, and ROI ratios for Class III appear to be stronger than the Northeast averages suggesting that farms with herd sizes of sixty to eighty cows were, in general, in a better financial position than others in the region. Comparisons of financial ratios in both 1983 and 1984 for each class with the regional figures indicate that no single class was consistently better than average. However, Class III, which appeared stronger than average in 1982, had financial ratios that were, for the most part, below those of the region in 1983. In 1984, farms in Class III had better than average DA, ROA, and ROE ratios, but their ROI measure was below average. DA, ROA, and ROE ratios for farms of Class IV were all below regional averages, yet ROI was above the Northeast figure.

In summary, during 1982 it appeared that Class III was financially better than other groups. In both 1983 and 1984 no herd size appeared to perform better than others. The intrayear comparisons among herd sizes suggest that there is no relationship between financial strength and herd size for the farms in this sample. That relationship is addressed in more detail below.

Financial characteristics by sales class. Farms were also classified into three sales categories based on gross returns. Average financial measures for farms in each sales category are reported in Table 4. The DA ratios for Class I and Class II were slightly lower in 1984 than in 1982. Over the sample period, the other financial measures deteriorated in all three sales classes. However, in a few instances ratios in 1983 improved over those in 1982 before they declined in 1984.

Comparisons between sales classes in each year suggest that no single sales class had financial ratios that were consistently better than regional averages for that year. In 1982, financial measures for Class II were all above regional averages. Conversely, ratios for Class II were all below regional levels in 1983. Financial indicators for Class I were lower than those of the region in 1984. The intrayear comparisons suggest that financial performance may not be linked to sales class.

Overall, the data presented in Table 2, Table 3, and Table 4 show that the average financial conditions of dairy farms in New England deteriorated only slightly between 1982 and 1984. It is also important to note that the average New England dairy farm was in a relatively desirable financial position throughout the three-year period. DA ratios did not exceed 32 percent and typically were below 25 percent. Further, rates of return on assets, equity, and investment did not dip below 7 percent and were generally well above that level.

Financial position of individual farms. The preceding discussion focused on aggregate financial conditions for New England dairy farms. In what follows, Melichar's criteria are used to classify farms according to their individual financial performance. Under that scheme, farms are categorized in good, fair, stressed, or vulnerable positions. According to Melichar, farms classified as vulnerable are currently in financial trouble. A farm in the stressed position is headed for trouble in the next few years unless returns improve. Farms that are in the fair category may not be able to sustain their equity level over the long term, but are unlikely to default on their loans.

Table 5 reports the results based on Melichar's classification scheme for the entire New England sample. In all three years more than 81 percent of the farms were classified as being in good financial position. However, the percentage of farms in that category declined by 4.7 percentage points over the three-year period. During the same period, farms classified in the fair category increased two percentage points, from 8.1 percent to 10.1 percent. The percentage of farms in the stressed category was constant, but farms in the vulnerable

Table 4. Financial Characteristics of Selected New England Dairy Farms by Sales Class: 1982–84

	Sales Class I[a]			Sales Class II[b]			Sales Class III[c]			Entire Region		
	1982	1983	1984	1982	1983	1984	1982	1983	1984	1982	1983	1984
Number of Farms	49	46	51	84	85	82	16	18	16	149	149	149
Cows/ Farm	40	40	40	69	68	69	137	130	137	66	67	66
Total Gross Returns	72,754	75,500	73,010	150,911	155,271	155,715	314,621	358,410	327,459	142,788	155,184	145,849
Gross Rets. (Milk)	69,711	72,290	68,635	144,943	147,436	146,858	299,375	296,475	301,391	136,786	142,241	136,678
Net Farm Income	14,331	15,317	12,579	29,980	27,847	25,734	52,791	45,284	38,194	27,283	26,085	22,569
Assets	198,738	198,235	226,791	341,662	347,901	360,333	587,214	583,121	679,092	321,028	330,111	348,853
Debt	44,734	47,208	48,449	72,035	65,436	66,098	130,174	112,324	162,927	69,300	65,473	70,455
Net Worth	158,348	201,143	180,597	270,607	283,261	294,639	467,930	448,613	513,783	254,878	277,885	279,136
DA Ratio[d]	21.3	23.0	20.4	21.4	23.0	18.9	22.8	20.4	24.8	21.7	20.7	20.6
ROA	10.7	10.1	7.3	11.9	9.8	8.9	10.9	10.5	8.1	11.5	10.0	8.4
ROE	11.3	15.0	9.2	12.7	11.6	10.5	10.9	10.3	7.0	12.0	11.8	9.5
Investment	195,338	196,916	225,604	331,194	342,661	350,616	578,680	544,768	662,502	314,220	322,081	314,318
ROI	10.9	10.2	7.4	12.4	9.7	11.2	11.0	11.5	8.4	11.8	10.3	9.9

[a]Sales Class I: gross farm returns are <$100,000.

[b]Sales Class II: gross farm returns are ≥$100,000 but ≤$250,000.

[c]Sales Class III: gross farm returns are >$250,000.

[d]Terms defined in footnote to Table 2.

Table 5. Financial Position for a Selected Sample of New England Dairy Farms[a]

Financial Position	All Farms					
	1982		1983		1984	
	N	(%)	*N*	(%)	*N*	(%)
Good	128	85.9	126	84.6	121	81.2
Fair	12	8.1	16	10.7	15	10.1
Stressed	6	4.0	5	3.4	6	4.0
Vulnerable	3	2.0	2	1.3	7	4.7
Total	149	100.0	149	100.0	149	100.0

[a]Financial position classification is based on criteria developed by Melichar. Same farms all three years.

position increased by 2.7 percentage points over the period.

Financial position by herd size. The sample was classified into Melichar's four stress categories based on herd size (Table 6). A review of the percentage of farms in the stressed and vulnerable categories within a particular year suggests that financial stress may be related to farm size. The most significant change occurred within herd size Class I where farms in the stressed and vulnerable positions increased from 9.4 percent in 1982 to 19.3 percent in 1984. That increase of 9.9 percentage points was by far the largest for any of the four classes. Farms in the two stressed categories within Class III and Class IV increased by 4 and 2.9 percentage points, respectively, over the same period. By 1984, no farms in Class II were in the stressed or vulnerable position. The data suggest that farms with less than 40 cows (Class I) experienced greater stress than did farms in the other classes.

Financial position by sales class. The previously defined sales classes were also

Table 6. Financial Position[a] of a Selected Sample of New England Dairy Farms According to Herd Size

	1982			1983			1984		
	No. of Farms	% of Size	% Overall	No. of Farms	% of Size	% Overall	No. of Farms	% of Size	% Overall
Class I[b]									
Good	24	75.0	16.1	23	82.1	15.4	21	67.7	14.1
Fair	5	15.6	3.4	4	14.3	2.7	4	12.9	2.7
Stressed	3	9.4	2.0	0	0.0	0.0	1	3.2	0.7
Vulnerable	0	0.0	0.0	1	3.6	0.7	5	16.1	3.4
Class II[c]									
Good	40	88.9	26.9	35	81.4	23.5	37	88.1	24.8
Fair	3	6.7	2.0	6	14.0	4.0	5	11.9	3.4
Stressed	1	2.2	0.7	2	4.6	1.3	0	0.0	0.0
Vulnerable	1	2.2	0.7	0	0.0	0.0	0	0.0	0.0
Class III[d]	33	86.8	22.1	39	88.6	26.2	35	83.3	23.5
Fair	2	5.3	1.3	3	6.8	2.0	2	4.8	1.3
Stressed	2	5.3	1.3	1	2.3	0.7	3	7.1	2.0
Vulnerable	1	2.6	0.7	1	2.3	0.7	2	4.8	1.3
Class IV[e]									
Good	31	91.2	20.8	29	85.3	19.5	28	82.4	18.8
Fair	2	5.9	1.3	3	8.8	2.0	4	11.8	2.7
Stressed	0	0.0	0.0	2	5.9	1.3	2	5.8	1.3
Vulnerable	1	2.9	0.7	0	0.0	0.0	0	0.0	0.0
Total	149		100.0	149		100.0	149		100.0

[a]Financial position classification is based on criteria developed by Melichar. Same farms all three years.

[b]Herd Size Class I: ≤40 cows.

[c]Herd Size Class II: >40 but <60 cows.

[d]Herd Size Class III: ≥60 but <80 cows.

[e]Herd Size Class IV: ≥80 cows.

used as a basis for examining the financial performance of individual farms. The results (Table 7) give additional evidence indicating that smaller farms were worse off financially than larger farms. The percentage of farms within Class I in the vulnerable position increased from 0 percent to 9.8 percent over 1982–84. Class II farms in the vulnerable position declined by 1.2 percentage points over the same period, while none of the farms in Class III were in that position during any of the years analyzed. However, there was a shift of farms in Class III from the good position into the fair and stressed positions. Overall, the sales class data support the conclusion that smaller dairy farms in New England may have experienced more financial stress than larger ones.

Summary and Conclusions

This paper investigates the level of financial stress for a selected sample of New England dairy farms during 1982–84. Subregions, herd sizes, and sales classes were studied. The reader should exercise caution in interpreting the results because net farm income calculations do not incorporate depreciation adjustments due to limitations in the data.

Aggregate financial ratios suggested that Vermont dairy farms had the strongest performance, and no single herd size or sales class appeared to outperform the region as a whole. Farms were also classified into four performance groups based on individual farm financial characteristics. The financial position classification indicated that, for the region as a whole, more than 80 percent of the dairy farms were in "good" financial shape, while less than 5 percent were financially stressed or vulnerable. However, a relationship between farm size and financial performance was found. In particular, a higher percentage of smaller farms (measured by herd size or sales class) moved into a stressed or vulnerable position.

In general, the results indicate that the ELFAC dairy farms in the sample were not severely stressed and that their financial position did not deteriorate substantially from 1982–84. The findings may be linked to the fact that ELFAC farmers, as do other farmers who participate in farm record programs, have the opportunity to improve management decisions by systematically monitoring receipts, expenditures,

Table 7. Financial Position of a Selected Sample of New England Dairy Farms According to Sales Class[a]

	1982			1983			1984		
	No. of Farms	% of Size	% Overall	No. of Farms	% of Size	% Overall	No. of Farms	% of Size	% Overall
Class I[b]									
Good	40	81.6	26.8	35	76.0	23.5	36	70.5	24.2
Fair	5	10.2	3.4	9	19.6	6.0	7	13.7	4.7
Stressed	4	8.2	2.7	1	2.2	0.7	3	5.9	2.0
Vulnerable	0	0.0	0.0	1	2.2	0.7	5	9.8	3.4
Class II[c]									
Good	72	85.7	48.3	76	89.4	51.0	74	90.2	49.7
Fair	7	8.3	4.7	6	7.1	4.0	5	6.2	3.4
Stressed	2	2.4	1.3	2	2.4	1.3	1	1.2	0.7
Vulnerable	3	3.6	2.0	1	1.1	0.7	2	2.4	1.3
Class III[d]									
Good	16	100.0	10.7	15	83.3	10.1	12	75.0	8.1
Fair	0	0.0	0.0	1	5.6	0.7	3	18.8	2.0
Stressed	0	0.0	0.0	2	11.1	1.3	1	6.2	0.7
Vulnerable	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
Total	149		100.0	149		100.0	149		100.0

[a]Financial position classification is based on criteria developed by Melichar. Same farms all three years.

[b]Sales Class I: gross farm returns are <$100,000.

[c]Sales Class II: gross farm returns are ≥$100,000 but <$250,000.

[d]Sales Class III: gross farm returns are ≥$250,000.

inventory, and other key variables that affect profitability.

This study also demonstrates that the conclusions, regarding financial performance, derived from the aggregate analysis of financial ratios, are different from those obtained from the analysis that classified farms according to individual financial characteristics. This point is noteworthy because much of the analysis conducted with data sets similar to the one used here are completed only at the aggregate level.

Although this sample of New England dairy farms showed healthy financial positions overall, some dairy farms in the region are financially stressed and some leave the industry each year. Inefficiencies, pressure from real estate developers, and increased financial burden may be factors contributing to the exodus. Additional research is needed, however, to determine the reasons farmers leave the industry and the factors that underlie financial performance.

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The Cost of Purchasing Crop Insurance: Examining the Sensitivity of Farm Financial Risk

Jerry R. Skees and Perry J. Nutt

Abstract

This research uses a Monte Carlo simulation model to examine how the cost of crop insurance affects farms with different initial debt loads. Crop insurance premium rates at and below a break-even level (i.e., where long-run indemnities are equal to premium costs) are examined. It is demonstrated that the cost of crop insurance becomes an important issue as yield risk and initial debt levels increase. The results raise serious questions regarding credit policies that require debtors to purchase crop insurance without consideration of expected farm-level loss ratios.

Key words: crop insurance, yield risk, loss ratios, Monte Carlo simulation, financial risk.

Crop insurance provides opportunities for income and yield risk protection. Creditors recognize the potential benefits and, in some cases, are requiring borrowers to purchase crop insurance. Although Federal Crop Insurance (FCI) has made significant changes to provide coverage based on individual farm expected yields, crop insurance rates are not derived from estimates of an individual farm's yield risk. Thus, a credit policy that requires the purchase of crop insurance, without consideration of how the premium cost compares with the expected losses, may adversely affect financially stressed farmers.

This research demonstrates the potential for adverse financial effects by focusing on farm-level crop insurance rates. The effects of purchasing crop insurance are measured assuming different premium costs, yield risk environments, and debt-to-asset ratios. Moreover, procedures for developing and understanding farm-level loss ratios (i.e., expected indemnities divided by expected premiums) are presented.

Previous research on crop insurance has not given attention to expected farm-level loss ratios. Pfleuger and Barry used a Monte Carlo simulation model to evaluate the effects of crop insurance on risk and how creditors may respond. They compared two areas in Illinois that had different yield risks and incorporated existing premium rates. However, they were not explicit about the expected farm-level loss ratios for the two areas. Therefore, comparability of results across the two yield risk environments was limited.

Studies utilizing Monte Carlo simulation to evaluate the farm-level effects of crop

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insurance have used typical farms and existing premium rates for a particular study area (Lemieux et al.; Leatham et al.). However, yield risks can vary significantly across farms, and rate structures for FCI have not been developed from participation by typical farms. Skees and Reed note that the rates have been developed from a group of farms that were adversely selected over time. Therefore, a key element in crop insurance analyses is recognizing the financial implications associated with various loss ratios. Studies that develop yield risk measures for typical farms in an area and use existing premium rates, without reporting the effects of the underlying farm-level loss ratio, may be biased regarding the potential benefits of crop insurance.

Understanding Farm-Level Crop Insurance Rates

The most significant change in FCI has been a move toward individual coverage based on each farm's own production history (Federal Crop Insurance Act of 1980). This program is known as Actual Production History (APH). FCI uses farm records and/or transitional yields (i.e., adjusted county ASCS data) to develop APH yields. In the absence of yield trends, APH yields should approximate expected yields (small samples can be a problem because averages are calculated with ten years of data; see Skees and Reed for a discussion of problems with APH). This paper will ignore yield trends for simplicity and assume that expected yields and APH yields are equal.

Insurance is purchased as a percent of APH yields (50, 65, and 75 percent protection levels are available). Also, farmers choose one of three price protection levels (i.e., payments are made on the difference between coverage guarantees—APH times percent protection—and actual yields). Thus, farmers have nine combinations to consider when purchasing crop insurance. If the loss ratios are equal for all options, then the choice is contingent upon the farmer's risk preferences. This study examines the highest protection options (i.e., 75 percent yield guarantee level with the highest price selection) in order to consider the maximum extent of risk protection offered.

The FCI focus on farm-level information concerns the development of APH yields as a proxy for expected yields. However, farm-level data are not used to develop measures of dispersion or farm-level rates. Rates at the farm level are developed from historical experience within a geographic region (usually a county). FCI uses a yield span relationship to reduce rates as APH yield increases (see Skees and Reed for justification of the procedures). Thus, there remains considerable opportunity for rate differences for individual farms and what is called the break-even farm rate (BEFR) (where expected indemnity payments will equal premium payments). The aim of this research is to explore the financial effects when the actual rate is not equal to the BEFR and how these effects change under various yield risk environments, loss ratios, and debt-to-asset ratios.

The calculation of a loss ratio on an ex post basis is straightforward: one divides the indemnities received by the premiums paid. A starting point in developing an expected loss ratio is the calculation of a BEFR. Knowledge regarding expected losses is needed to develop a BEFR. Expected losses can be estimated by integrating the region of the yield probability distribution that lies below the coverage level:

$$EL = \int_{-\infty}^{Y_g} (Y_g - Y)\, f(Y)\, dy, \tag{1}$$

where EL represents expected losses (in bushels); Y_g is the yield guarantee (APH yield multiplied by the yield protection level—50, 65, or 75 percent); Y is the actual yield; and $f(Y)$ is the probability density function for yields.

If the distribution is normally distributed, expected losses can be estimated by the following equations (Botts and Boles):

$$Z = \left[\frac{1}{\sqrt{2\pi}}\right] \cdot e^{-\frac{1}{2} \cdot \left[\frac{E_y - Y_g}{SD}\right]^2}, \tag{2}$$

$$T = 1/\left\{1 + b\left[\frac{E_y - Y_g}{SD}\right]\right\}, \tag{3}$$

$$P = Z(a_1 T + a_2 T^2 + a_3 T^3), \tag{4}$$

$$EL = P(Y_g - EY) + Z(SD), \tag{5}$$

where $b = .33267$, $a_1 = .4361836$, $a_2 = -.1201676$, and $a_3 = .937298$ (Abramowitz and Stegun). Other variables include: *EY*, expected yield; *SD*, standard deviation; *P*, probability of collecting in any given year; and *Z* and *T* (defined above or developed through intermediate calculations).

Once expected losses are developed, a BEFR can be calculated:

$$R = (EL/Y_g) \tag{6}$$

where *R* is equal to the BEFR. FCI uses rates to simplify the calculation of premiums. Given a rate, one can convert to a dollar per acre value (premium):

$$PR = R * Y_g * P_g, \tag{7}$$

where *PR* is the premium, P_g is the price guarantee level, and Y_g and *R* are defined as before. Thus, in order to obtain a farm-level break-even *premium*, the expected losses must be calculated using a known yield distribution, yield guarantee, and price protection level.

Expected losses can also be calculated from any empirical distribution (such as those that are generated when performing Monte Carlo simulation). Equation 8 reveals this procedure:

$$EL = \left[\sum_{i=1}^{n} (Y_i - Y_g)\right]/n; \text{ when } Y_g > Y_i, \tag{8}$$

where Y_i is the observed yield and *n* is the number of random yields developed. This provides the essential information for developing a BEFR. Subsequently, a farm's BEFR can be compared with the actual rate being charged (i.e., a loss ratio). In order to develop a farm-level loss ratio one divides the BEFR by the actual rate:

$$\textit{Loss Ratio} = \textit{BEFR/Rate Charged} \tag{9}$$

An experimental design for developing representative risk environments. To be applicable across regions, it was necessary to develop yield risk environments that are representative of many corn and soybean producing areas. Black et al. used historical yield data obtained from Farm Business Analysis Records in five states (Michigan, Minnesota, Kentucky, Kansas, and Illinois) to develop information on yield distributions. Shapiro-Wilks test for normality suggested that the normality assumption could not be rejected for a large percentage of the farm-level yield distributions. However, in some states there was evidence of negatively skewed distributions. This information was used to develop yield risk environments that would represent a range of possibilities.[1]

First, two normal distributions were developed with a coefficient of variation (CV) of 25 and 35 percent for both corn and soybeans. The distributions were modified by forcing the lowest 2 percent of the random yield draws to equal zero. This provided the opportunity for catastrophic losses for corn and soybeans 2 percent of the time, resulting in negatively skewed yield distributions.

Using the numerical integration procedures in equation 8, a BEFR was calculated for each yield risk environment. Assuming farmers purchase insurance at the 75 percent yield protection level, the following BEFRs were obtained for each random data set:

Low Risk (.25 CV)		*High Risk* (.35 CV)	
Normal	*Neg. Skewed*	*Normal*	*Neg. Skewed*
2.55%	3.45%	6.20%	6.50%

Expected corn yield is 120 bushels per acre, and expected soybean yield is 40 bushels per acre. With the price protection level of $2.35 per bushel of corn and $5.25 for soybeans, break-even premiums (*CPR* = corn premium and *BPR* = soybean premium) for each risk environment are calculated as follows:

[1]Black et al. found that a large percentage of the farms faced crop insurance rates above break-even levels (i.e., farm-level loss ratios were less than 1) despite subsidies ranging from 19–30 percent of the premium and 100 percent of the administrative cost. This demonstrates the problems with developing rates for a diverse set of farms and the importance of considering farm-level loss ratios. Examining loss ratios and assuming that farm-level risks are similar is incorrect. Farmers who purchase crop insurance are adversely selected, and the rates reflect that adverse selection.

Low Risk (.25 CV, normally distributed)
CPR = (.0255 * (120 * .75) * 2.35)
= $5.39/acre
BPR = (.0255 * (40 * .75) * 5.25)
= $4.02/acre

Low Risk (.25 CV, negatively skewed with a 2% catastrophic load)
CPR = (.0345 * (120 * .75) * 2.35)
= $7.30/acre
BPR = (.0345 * (40 * .75) * 5.25)
= $5.43/acre

High Risk (.35 CV, normally distributed)
CPR = (.062 * (120 * .75) * 2.35)
= $13.11/acre
BPR = (.062 * (40 * .75) * 5.25)
= $10.76/acre

High Risk (.35 CV, negatively skewed with a 2% catastrophic load)
CPR = (.065 * (120 * .75) * 2.35)
= $13.74/acre
BPR = (.065 * (40 * .75) * 5.25)
= $10.23/acre

where *CPR* is equal to the crop insurance premium per acre of corn and *BPR* is equal to the crop insurance premium per acre of soybeans.

The Method

The model used is a recursive Monte Carlo simulation model that simulates annual production, management, and income aspects of a farm or farms over a multiple-year planning horizon (a ten-year horizon was used; Skees). Because this paper follows research conducted with similar methods, it is assumed that readers are familiar with financial Monte Carlo models (see Richardson and Nixon; Skees; and Walker and Helmers), and only the critical aspects of this model are provided.

The model simulates corn-soybean farms and relies on economic and cash accounting to determine the financial well-being of a farm through time. The recursive nature of the model stems from using the current year's ending financial position as the beginning financial position for the next year. The outcomes are a function of multivariate pseudo-random prices and yields that are correlated (a multivariate normal process generator developed by King was used). While there is some evidence that in the major corn-soybean region(s) of the U.S. prices and yields may be correlated, for many areas, no such relationship is likely to exist. Thus, the correlation between prices and yields was assumed to be zero. Prices are correlated through time, and yields are correlated within the same year (.5 correlation between yields for the analyses presented).

The long-run financial implications of crop insurance at the firm level are dependent on a number of factors: (*a*) the relationship between insurance premiums and expected indemnities (i.e., the loss ratio of the insurance), (*b*) the cost of borrowing—do bankers charge more for operating capital required to offset negative cash flows that are caused by either yield shortfalls or payments on insurance premiums? (*c*) the progressive tax system—by purchasing crop insurance farmers will reduce the variability in marginal tax brackets and, thus, the variability in after-tax income, and (*d*) the proportion of equity in land versus other assets—by refinancing land, land owners should be better able to self-insure in short crop years, provided they have sufficient equity. Such a variety of influences complicates the basic question: will crop insurance help a financially stressed farmer? With the aim of focusing on the effects of different loss ratios given certain yield risk environments, it was necessary to "control" the four factors by making them similar across farms.

Among the most critical assumptions made are those regarding the relationships between returns, inflation, and interest rates. While the model can account for inflation, doing so requires forecasts of a number of volatile variables: inflation of cost of production, product prices, land, and so forth. Developing a financial model for even a relatively short time period places a tremendous burden on the forecasts, particularly if they are assumed to remain constant. Depending on the forecasts, a growth or a nongrowth situation may be incorporated into the model. Obviously, the scenarios will have a positive or negative effect upon the model results. Moreover, such effects make it difficult to separate from the results the financial effects of purchasing crop insurance.

Therefore, an equilibrium model with a zero inflation environment was developed.

An equilibrium model is needed when comparing farms that have different debt-to-asset ratios (i.e., farms with different debt levels will possess different growth rates). Therefore, an equilibrium scenario was developed within the simulation model before determining the effects of purchasing crop insurance. Assuming zero inflation, the key financial relationship to establish equilibrium (i.e., a scenario where the cost of capital is equal to the return to equity) concerns the rate of return to equity capital relative to the cost of borrowed capital. Establishing land values at a level that will cause the rate of return to equity to equal the interest rate will result in a financial environment whereby the effects of financial leverage are negated. This provides a constant financial position throughout the planning horizon and allows the isolation of the financial effects of purchasing crop insurance.

Without inflation and the appropriate measures of risk surrounding interest rates, it was necessary to establish interest rates on a real basis. Interest rates were established at 4 percent for operating interest, 3.5 percent for intermediate loans, and 3 percent for fixed loans (primarily land). Land prices were set at a level that resulted in a net present value of growth in net worth that was equal to the average interest rate of 3.5 percent. Thus, the rate of return to equity was established at a level equal to the average interest rate. Developing this capital equilibrium provides the needed control for isolating the farm-level effects of crop insurance.

An Analysis of Survivability with Crop Insurance

The results represent the analysis of multiple-peril crop insurance assuming different initial equity positions, yield risk environments, and expected loss ratios. The results were generated with an equilibrium environment that negates the positive and/or negative effects of financial leverage (i.e., growth or retrenchment), thereby leading to results reflective of the purchase of crop insurance only.

An essential assumption in simulating the temporal viability of a farm business concerns the determination of when a farmer is forced to liquidate. In the model, each farm must balance end-of-the-year cash flows. If a negative cash position is realized, the farmer may be allowed to obtain a one-year loan. The following requirements must be met for the loan to be available: (*a*) the principal cannot exceed the negative cash amount, (*b*) current liabilities cannot be more than one-and-one-half times current assets, and (*c*) current liabilities cannot exceed 50 percent of expected annual gross returns. In certain extreme cases, those conditions may be exceeded. If so, refinancing using long-term equity (i.e., land) is allowed to cover the cash deficit (a 2 percent refinancing charge is incurred). Finally, the farm business is liquidated if the debt-to-asset ratio exceeds 85 percent for two consecutive years and any remaining equity is placed in a savings account that earns 3.5 percent. Although this indicator (i.e., 85 percent or more debt-to-asset for two years) is arbitrary, it does provide a consistent measure for evaluating financial stress and reflecting odds of survival.

The hypothetical farm consists of 600 acres, with a fifty-fifty crop mix of corn and full-season soybeans. The results represent this farm situation assuming: (*a*) four risk environments (with CV of 25 percent, CV of 35 percent, and with and without a 2 percent chance of zero yields), (*b*) four expected-loss ratios (1.0, .8, .6, and .4),[2] and (*c*) four initial debt-to-asset positions (0, .5, .8, and .85). In each scenario, all of the land is owned, no off-farm income is allowed, the same amount of unpaid labor (1.5 man years) is used, and the same consumption function (used to calculate family living expenses) is utilized. Also, the effects of the Tax Reform Act of 1986 are accounted for.

The measurement variable used in the analysis is generated wealth (*GW*). This variable is consistent with arguments made by Eidman for evaluating the financial

[2]Loss ratios greater than 1 assure a higher expected value and a lower variance (i.e., risk-averse and risk-neutral farmers will prefer this scenario). It is only for loss ratios less than 1 that the decision to purchase crop insurance becomes interesting.

well-being of family farms over time. Generated wealth includes the future value of a stream of family living withdrawals, plus the change in net worth over the time horizon

$$GW = (NW_{t=10} - NW_{t=0}) + \sum_{t=1}^{10} C(1 + r)^t, \quad (9)$$

where

NW = net worth,
C = family living withdrawals,
r = average interest rate of 3.5 percent, and
t = year.

Repeated use of the model provided the opportunity to develop summary statistics with and without the purchase of crop insurance. Comparing differences for the same set of relevant assumptions for the two options (i.e., with and without the purchase of crop insurance) provides the needed insights into how crop insurance will change expected performance measures (generated earnings and odds of survival).

Results

Generated wealth measures for the four different risk environments are summarized in Tables 1–4. In every case where insurance is priced at a break-even level (expected loss ratio = 1), there are positive gains in the mean value of generated wealth. This is due to the effects of a progressive tax system when crop insurance is purchased. Specifically, crop insurance premiums lower the upper most bound of taxable income, and in low yield years, indemnities raise the lower bound of taxable income. Therefore, farmers who choose to purchase crop insurance have a less variable taxable income compared with those who choose not to participate. This leads to a lower average tax rate being paid by the farmer who purchases crop insurance. For loss ratios equal to one, the differences between the insurance and the no insurance runs are greatest in the high-risk environments (i.e., the yield risk environments with a CV of .35, with and without catastrophic loading). Therefore,

Table 1. Generated Wealth With and Without Insurance for Low-Risk Environment—Normal Distribution, .25 CV

Loss/Cost Ratio		DA 0.0			DA .50		
		Ins.	No Ins.	Diff.	Ins.	No Ins.	Diff.
1.0	mean	$795,288	$792,776	$2,512	$576,366	$573,017	$3,349
	S.D.	133,115	142,560	−9,445	146,661	156,394	−9,733
.8	mean	788,257	792,776	−4,519	568,416	573,017	−4,601
	S.D.	133,168	142,560	−9,392	146,893	156,394	−9,501
.6	mean	776,275	792,776	−16,501	555,037	573,017	−17,980
	S.D.	133,267	142,560	−9,293	147,124	156 394	−9,270
.4	mean	752,349	792,776	−40,427	528,242	573,017	−44,775
	S.D.	133,570	142,560	−8,990	147,761	156,394	−8,633
		DA .80			DA .85		
1.0	mean	$431,975	$426,242	$5,733	$383,399	$379,634	$3,765
	S.D.	157,608	172,279	−14,671	187,832	196,298	−8,466
.8	mean	423,649	426,242	−2,593	374,038	379,634	−5,596
	S.D.	158,013	172,279	−14,266	189,003	196,298	−7,295
.6	mean	409,602	426,242	−16,640	355,422	379,634	−24,212
	S.D.	158,679	172,279	−13,600	190,379	196,298	−5,919
.4	mean	380,725	426,242	−45,517	319,847	379,634	−59,787
	S.D.	160,673	172,279	−11,606	193,102	196,298	−3,196

Assumes 50 percent crop mix and .5 correlation between yields for a 600-acre farm with all land owned. S.D. is the standard deviation associated with a certain wealth level.

Table 2. Generated Wealth With and Without Insurance for the High-Risk Environment—Normal Distribution, .35 CV

Loss/Cost Ratio		DA 0.0			DA .50		
		Ins.	No Ins.	Diff.	Ins.	No Ins.	Diff.
1.0	mean	$797,352	$789,474	$7,878	$574,725	$565,704	$9,021
	S.D.	158,302	181,463	−23,161	172,677	195,579	−22,902
.8	mean	779,733	789,474	−9,741	555,124	565,704	−10,580
	S.D.	158,338	181,463	−23,125	172,988	195,579	−22,591
.6	mean	750,106	789,474	−39,368	522,198	565,704	−43,506
	S.D.	158,513	181,463	−22,950	173,520	195,579	−22,059
.4	mean	690,132	789,474	−99,342	456,255	565,704	−109,449
	S.D.	159,401	181,463	−22,062	174,072	195,579	−21,507
		DA .80			DA .85		
1.0	mean	$425,664	$413,534	$12,130	370,115	$357,784	$12,331
	S.D.	188,504	218,156	−29,652	216,972	235,052	−18,080
.8	mean	404,712	413,534	−8,822	346,146	357,784	−11,638
	S.D.	188,787	218,156	−29,369	215,461	235,052	−19,591
.6	mean	369,443	413,534	−44,091	305,040	357,784	−52,744
	S.D.	189,801	218,156	−28,355	216,440	235,052	−18,612
.4	mean	294,929	413,534	−118,605	229,211	357,784	−128,573
	S.D.	193,085	218,156	−25,071	215,629	235,052	−19,423

Assumes 50 percent crop mix and .5 correlation between yields for a 600-acre farm with all land owned. S.D. is the standard deviation associated with a certain wealth level.

Table 3. Generated Wealth With and Without Insurance for Low Risk With Catastrophic Load—Skewed Normal, .25 CV

Loss/Cost Ratio		DA 0.0			DA .50		
		Ins.	No Ins.	Diff.	Ins.	No Ins.	Diff.
1.0	mean	$785,404	$779,829	$5,575	$565,277	$559,331	$5,946
	S.D.	132,956	150,119	−17,163	146,735	164,453	−17,718
.8	mean	775,650	779,829	−4,179	554,324	559,331	−5,007
	S.D.	133,028	150,119	−17,091	146,917	164,453	−17,536
.6	mean	759,535	779,829	−20,294	536,264	559,331	−23,067
	S.D.	133,209	150,119	−16,910	147,389	164,453	−17,064
.4	mean	726,770	779,829	−53,059	499,659	550,331	−59,672
	S.D.	133,754	779,829	−16,369	148,007	164,453	−16,446
		DA .80			DA .85		
1.0	mean	$420,284	$411,374	$8,910	$368,903	$362,532	$6,371
	S.D.	157,894	181,870	−23,976	187,551	206,216	−18,665
.8	mean	408,894	411,374	−2,480	355,507	362,532	−7,025
	S.D.	158,453	181,870	−23,417	189,511	206,216	−16,705
.6	mean	389,746	411,374	−21,628	330,833	362,532	−31,699
	S.D.	159,300	181,870	−22,570	193,118	206,216	−13,098
.4	mean	349,500	411,374	−61,874	282,910	362,532	−79,622
	S.D.	162,866	181,870	−19,004	196,500	206,216	−9,716

Catastrophic loading involves forcing the lower 2 percent of draws from a normal distribution to zero. Table assumes 50 percent crop mix and .5 correlation between yields for a 600-acre farm with all land owned. S.D. is the standard deviation associated with a certain level of wealth.

Table 4. Generated Wealth With and Without Insurance for High Risk With Catastrophic Load—Skewed Normal, .25 CV

Loss/Cost Ratio		DA 0.0			DA .50		
		Ins.	No Ins.	Diff.	Ins.	No Ins.	Diff.
1.0	mean	$794,059	$785,532	$8,527	$571,098	$561,688	$9,410
	S.D.	158,294	183,656	−25,362	172,723	197,735	−25,012
.8	mean	775,852	785,532	−9,680	550,782	561,688	−10,906
	S.D.	158,339	183,656	−25,317	173,079	197,735	−24,656
.6	mean	744,758	785,532	−40,774	516,432	561,688	−45,256
	S.D.	158,553	183,656	−25,103	173,542	197,735	−24,193
.4	mean	680,647	785,532	−104,885	445,675	561,688	−116,013
	S.D.	159,557	183,656	−24,099	174,250	197,735	−23,485
		DA .80			DA .85		
1.0	mean	$421,761	$409,453	$12,308	$364,389	$353,686	$10,703
	S.D.	188,508	220,331	−31,823	215,944	237,268	−21,324
.8	mean	400,123	409,453	−9,330	339,942	353,686	−13,744
	S.D.	188,789	220,331	−31,542	213,961	237,268	−23,307
.6	mean	363,117	409,453	−46,336	297,638	353,686	−56,048
	S.D.	189,813	220,331	−30,518	217,325	237,268	−19,943
.4	mean	283,387	409,453	−126,066	216,966	353,686	−136,720
	S.D.	193,530	220,331	−26,801	215,141	237,268	−22,127

Catastrophic loading involves forcing the lower 2 percent of draws from a normal distribution to zero. Table assumes 50 percent crop mix and .5 correlation between yields for a 600-acre farm with all land owned. S.D. is the standard deviation associated with a certain level of wealth.

the relative reduction in the tax rate is the greatest for the high-risk scenarios. However, because tax rates (brackets) under the Tax Reform Act of 1986 are less progressive than previous tax rates, crop insurance may be less attractive than it has been in the past.

Comparing mean values of generated wealth (with and without crop insurance) under a loss ratio of .8 suggests that the effect upon cash flows will be detrimental. The negative cash flow effects from purchasing crop insurance at that level dominate the benefits of the progressive tax structure. At loss ratios of .6 and .4, there are further reductions in generated earnings. The results demonstrate that farmers will have to be willing to give up income to acquire risk protection at those loss-cost levels.

Because the purchase of crop insurance provides protection on the low end of the yield distribution, one may expect the distribution of income measures to be positively skewed. The distributions of generated wealth were tested for normality using the Kolomogorov *D* statistic. The assumption of normality could not be rejected at the 1 percent significance level. It is likely that the smoothing effects of a multiple-year analysis result in distributions that are more normally distributed.

Given that the normality assumption cannot be rejected for generated wealth distributions, one way to examine the results is to use the coefficient of variation statistic.[3] Those values are presented in Table 5 as a means of examining the relative risk changes when crop insurance is purchased. In Table 5 the CV of generated wealth with crop insurance is divided by the CV without crop insurance (all other factors remain the same). As the ratio decreases,

[3]More discriminating techniques would be needed if this research were designed to identify when certain classes of decision makers would purchase crop insurance. However, in light of the objectives, which are to map changes in risk with and without insurance under various farm-level loss ratios, a measure such as coefficient of variation (CV) is useful. It is especially true since CV measures change in relative risk. Thus, the mapping presented in Table 5 demonstrates the sensitivity. Any case where relative risk (as measured by CV) is greater with crop insurance than without will clearly be inferior for even the most risk-averse decision maker (EV analysis demonstrates that). Therefore, the break where ratios are greater than 1 represents a lower bound for considering the efficacy of crop insurance.

Table 5. Ratios of Coefficient of Variation (CV) on Generated Earnings
(CV With Insurance Divided by CV Without Insurance)

	DA Ratio Normal at .25 CV				DA Ratio Normal at .35 CV			
	0	**.5**	**.8**	**.85**	**0**	**.5**	**.8**	**.85**
Loss Ratio								
1.0	.9304	.9324	.9028	.9476	.8639	.8691	.8395	.8924
.8	.9395	.9469	.9229	.9773	.8836	.9014	.8843	.9475
.6	.9548	.9713	.9586	1.0360	.9195	.9612	.9739	1.0800
.4	.9874	1.0249	1.0443	1.1677	1.0050	1.1036	1.2411	1.4320
	DA Ratio Neg. Skewed at .25 CV (2% zero yields)				**DA Ratio Neg. Skewed at .35 CV** (2% zero yields)			
	0	**.5**	**.8**	**.85**	**0**	**.5**	**.8**	**.85**
Loss Ratio								
1.0	.8793	.8829	.8497	.8938	.8530	.8592	.8306	.8834
.8	.8909	.9014	.8765	.9371	.8732	.8927	.8768	.9382
.6	.9110	.9348	.9245	1.0262	.9109	.9546	.9714	1.0884
.4	.9560	1.0010	1.0540	1.2211	1.0030	1.1107	1.2691	1.4782

These values provide a measure of how relative risk and the ability to generate wealth change over a ten-year horizon when crop insurance is purchased. Values greater than one represent cases where the purchase of crop insurance actually increases the relative risk of generated earnings.

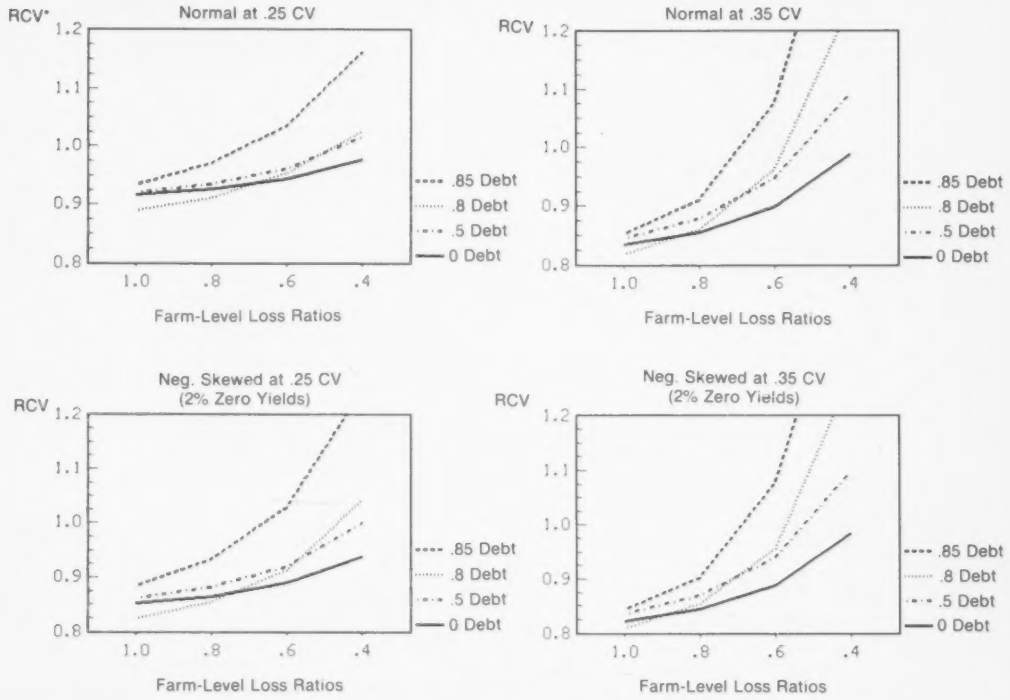
the relative risk associated with purchasing crop insurance declines (i.e., crop insurance becomes a better risk instrument).

For each debt-to-asset position, when normally distributed yields were compared with those that are negatively skewed, lower ratios were generally obtained as yield risk increased. Therefore, the relative benefits of purchasing crop insurance increase as the yield risk environment becomes more risky. However, the higher relative ratios suggest that at some point (high risk and high debt) the benefits of crop insurance will be overshadowed by the adverse financial effects associated with negative cash flows.

Results in Table 5 are presented graphically in Figure 1. Each graph represents a yield distribution with the CV ratio plotted against the farm-level loss ratio for each debt situation. In those graphs a very consistent pattern emerges; for each debt situation, as the farm-level loss ratio decreases, the relative ratio increases. This pattern indicates that the cost of insurance is an important consideration irrespective of the underlying yield risk. Another observation concerns the slope of each debt-to-asset line. The slope increases at a faster rate for the negatively skewed yield distributions versus the normal distributions. It demonstrates that the importance of the cost of crop insurance increases as yield risk increases.

Table 6 presents the odds of survival for the simulated farm with and without the purchase of crop insurance. Odds of survival do not change for the farms with 0 and .5 debt-to-asset levels, therefore, they are not reported. The farms with high initial debt levels experienced increased odds of survival over a ten-year horizon when crop insurance was priced at an expected loss ratio of 1. At the .8 loss ratio, the farm with high debt (.85 debt-to-asset ratio) experienced a decrease in the odds of survival in the highest risk environment (.35 CV, with catastrophic loading). Odds of survival were increased by the purchase of crop insurance in the other scenarios with the same loss ratio (.8). With a loss ratio of .6, the results are mixed. The low-debt farm (.8 debt-to-asset ratio) experienced increased odds of survival, while the high-debt farm's odds of survival were reduced. This result was consistent across the four yield risk environments. At the lowest loss ratio level (.4), each farm experienced either a reduction in odds of survival, or they remained unchanged. In

Figure 1. Comparing How Relative Risk Changes With the Purchase of Crop Insurance for Different Debt Levels, Loss Ratios, and Yield Risk Environments



*RCV is equal to the coefficient of variation of generated earnings with insurance divided by the same measure without insurance. If this ratio is less than 1, the relative risk of purchasing insurance is smaller than the relative risk associated with not purchasing crop insurance.

general, the results in Table 6 provide the same evidence as Table 5—the cost of crop insurance becomes an important consideration for farmers with high debt levels and for those exposed to high yield risks.

Summary and Conclusions

The procedures presented in this paper provide a basis for conducting future research regarding the role of crop insurance in risk management decision making. Furthermore, the procedures provide a methodical approach that builds upon concepts of insurance rate making and previous work on farm survival (Skees and Reed; Perry et al.; Skees and Reid).

In certain areas, crop insurance may be priced where some farms will experience loss ratios less than 1. Farmers should be interested in their expected loss ratios and in how they may affect their financial situation. Therefore, it is essential that future research conducted on crop insurance incorporates discussion of the probable effects of expected loss ratios. Studies that do not report loss ratios or the probable consequences are misleading.

This study demonstrates that the cost of crop insurance becomes an important decision-making element as debt levels and yield risk increase. That result merits concern because farmers in higher yield risk areas typically purchase more crop insurance than farmers in lower yield risk areas. High-debt farmers exposed to loss ratios below .6 will experience adverse financial effects (i.e., higher relative risk and lower probability of survival) when purchasing crop insurance. Credit policies that force those farmers to purchase crop

Table 6. Differences in Odds of Survival
(With Crop Insurance Minus Without Crop Insurance)

	Normal With .25 CV					
	DA .8			DA .85		
	Ins.	No Ins.	Diff.	Ins.	No Ins.	Diff.
Loss Ratio						
1.0	95%	94%	1%	79%	78%	1%
.8	95	94	1	79	78	1
.6	95	94	1	74	78	−4
.4	94	94	0	70	78	−8
	Normal with .35 CV					
	DA .8			DA .85		
	Ins.	No Ins.	Diff.	Ins.	No Ins.	Diff.
Loss Ratio						
1.0	94%	89%	5%	72%	68%	4%
.8	93	89	4	68	68	4
.6	92	89	3	62	68	−6
.4	86	89	−3	56	68	−12
	Neg. Skewed with .25 CV					
	DA .8			DA .85		
	Ins.	No Ins.	Diff.	Ins.	No Ins.	Diff.
Loss Ratio						
1.0	95%	93%	1%	78%	74%	4%
.8	95	93	1	75	74	1
.6	95	93	1	72	74	−2
.4	93	93	0	61	74	−13
	Neg. Skewed with .35 CV					
	DA .8			DA .85		
	Ins.	No Ins.	Diff.	Ins.	No Ins.	Diff.
Loss Ratio						
1.0	94%	89%	5%	71%	68%	3%
.8	93	89	4	67	68	−1
.6	92	89	3	62	68	−6
.4	86	89	−3	54	68	−14

The firm is insolvent if debt-to-asset ratio exceeds .85 for two consecutive years. Odds of survival count the number of insolvencies for the 100 simulations.

insurance need to be redirected. Furthermore, with current FCI administration costs (which are fully subsidized) exceeding 40 cents per dollar of premium, the possibility of private multiperil crop insurance appears impractical.

Finally, because the cost of crop insurance determines the success of using crop insurance for risk protection, research is needed that will assist farmers in developing estimates of their expected loss ratios. This is the most useful information that can be provided to a farmer attempting to make a decision concerning the purchase of crop insurance. Such research would help creditors be more discriminating in their decisions to force farmers into buying crop insurance and would help farmers who are in serious financial trouble make better informed risk management decisions.

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Commercial Bank Market Shares: Structural Factors Influencing Their Decline in the Agricultural Sector

Paul N. Wilson and David L. Barkley

Abstract

Declining agricultural-lending market shares for commercial banks for the period 1969–85 are investigated using cross-sectional data for forty-eight states. Factor analysis and multiple regression techniques reveal nonagricultural economic activity, risk, and bank structure are significant variables in explaining the differences in changing market shares across states.

Key words: market shares, banks, nonreal estate loans.

Recent evaluations of financial stress in the agricultural sector have devoted their attention to the liquidity and solvency positions of growers and agricultural lenders (Melichar 1984; USDA 1985, 1986b). Although this cyclical phenomenon has significant short- and long-run importance, there has occurred a more subtle structural change in the agricultural sector that also may have long-range implications for farm borrowers and lenders. This structural adjustment is, in many states, the shift of agricultural lending for nonreal estate purposes from commercial banks towards specialized agricultural lenders such as the Farm Credit System (FCS) and the Farmers Home Administration (FmHA) (Barry). For example, nationally, commercial banks' market share of nonreal estate agricultural lending declined from 43.3 percent in 1969 to 33.8 percent in 1982. During the same period, the FmHA increased its national market share of nonreal estate debt from 3 to nearly 14 percent while the market share of Production Credit Associations (PCA) and all other lenders remained stable. Casual empiricism indicates that banks have had more flexibility than the specialized agricultural lender in adjusting their loan portfolios in response to changing economic conditions. A shift of marginal agricultural borrowers from commercial banks to specialized lenders (e.g., FmHA) may have contributed to the recent financial stress in the government and quasi-public lending institutions. Furthermore, any additional contraction of lending activities by commercial banks to agriculture would further reduce the supply of credit to less financially solvent farmers. And as a result, additional political and financial pressures would be placed on the FCS and FmHA to supply affordable credit to rural areas.

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Earlier studies of changing market shares for nonreal estate lending provide two interpretations for the historical shift from commercial banks to specialized lenders. First, Calvert and Meltzer proposed that the decline in commercial bank market shares nationally is the result of cyclical fluctuations in aggregate economic activity and interest rates. Economic growth provides more nonagricultural lending opportunities for banks. In addition, during periods of rising (declining) interest rates, commercial banks lose (strengthen) their competitive position relative to government and quasi-public lending institutions because banks price their loans at marginal cost. Second, Melichar (1975) and Benjamin hypothesized that increased branch and multibank holding company activity may have contributed to reduced agricultural market shares for commercial banks in many states. Commercial banks in statewide branching and limited branching states, or those owned by multibank holding companies, may be more concerned with maximizing the value of their stockholders' equity than with meeting the financial needs of their traditional borrowers under all circumstances. Also, since deregulation, commercial banks of all types face increased competition for deposits and a greater variety of investment opportunities. As a result, commercial banks may have reoriented their loan portfolios towards the less risky commercial and industrial loans.

Fluctuations in aggregate economic activity and deregulation of financial markets are intuitively attractive interpretations of declining commercial bank market shares at the national level. Those explanations, however, provide only limited insight into the forces that have produced the diverse changes in market shares across states with similar banking structures or the great interstate variability in market share changes during similar stages of the business cycle (see Table 1). For example, from 1969 to 1982, commercial banks lost market share in all but three states, but the losses varied from 1.6 percent in Connecticut (13.8 to 12.2) to 32.3 percent in Nevada (46.5 to 14.2). Market share changes in statewide branching states ranged from .9 (New York) to −32.3 (Nevada), and the percent changes in states with predominantly unit banking varied from 14.7 (Massachusetts) to −26.3 (New Hampshire). Also notable is that market share changes in the agriculturally oriented Midwestern states were less dramatic than any other region of the country.

The purpose of this paper is to determine the extent to which changes in commercial bank nonreal estate lending to agriculture are associated with state economic, demographic, and structural characteristics. The paper is organized as follows. First, changes in commercial bank market shares are divided into three components, and the interstate differences in the components are reviewed. The market share components are estimated for the forty-eight contiguous states for 1969–82. Second, factor analysis and ordinary least squares (OLS) are employed to isolate the state characteristics that are statistically related to changes in commercial bank market shares. Finally, the authors provide empirical evidence that indicates that interstate differences in aggregate economic activity, banking structure, risk associated with agricultural and nonagricultural lending, and farm structure contributed to the determination of fluctuations in bank market shares.

Market Share Data

Change in commercial bank market shares can be decomposed into three principal components: portfolio decisions, loanable funds availability, and loan market size. Let the commercial bank's market share of nonreal estate agricultural loans (*MS*) be expressed as

$$MS = BAL/TAL = [(BAL/BD)^{*}BD]/TAL, \quad (1)$$

where *BAL* represents total bank agricultural loans, *TAL* is total agricultural loans outstanding in the state, and *BD* represents commercial bank deposits. Totally differentiating equation 1 yields

$$dMS = [d(ALDR)^{*}BD/TAL] + [ALDR^{*}d(BD)/TAL] - [ALDR^{*}BD^{*}d(TAL)/TAL^{2}], \quad (2)$$

where *ALDR* is the agricultural loan-to-deposit ratio for the commercial bank. By dividing equation 2 by equation 1 and rearranging terms, a percentage change

Table 1. Market Shares and Absolute Changes in Market Shares for Nonreal Estate Lenders, 1969–82[a]

	Lender							
	Commercial Banks		Production Credit Associations		Farmers Home Administration		All Others[b]	
Region/State	Share 1969	Change 1969–82	Share 1969	Change 1969–82	Share 1969	Change 1969–82	Share 1969	Change 1969–82
New England								
ME	14.4%	−8.4%	17.5%	0.8%	36.5%	5.6%	31.5%	2.1%
NH	33.9	−26.3	16.9	19.3	9.5	−0.2	39.6	7.3
VT	27.1	−9.1	32.0	−1.0	13.8	0.6	27.0	9.5
MA	26.5	14.7	29.0	−8.4	4.4	8.2	40.1	−14.5
RI	8.4	−6.0	38.4	4.0	5.8	8.4	47.3	−7.2
CT	13.8	−1.6	38.0	0.1	5.6	11.8	42.6	−10.3
Mid-Atlantic								
NY	36.9	0.9	30.6	−9.5	6.9	10.4	25.5	−1.8
NJ	25.6	−20.4	27.6	1.3	9.5	12.8	37.3	5.3
PA	46.7	−19.9	18.5	5.1	4.0	8.3	30.8	6.5
East North Central								
OH	34.3	−11.4	29.6	4.0	1.7	7.3	34.5	0.0
IN	43.4	−12.2	23.6	−1.4	2.2	8.6	30.7	5.1
IL	54.7	−10.8	12.6	−1.6	2.2	3.4	30.5	8.9
MI	45.3	−21.2	23.4	2.7	3.8	12.7	27.5	5.8
WI	39.3	−10.4	32.9	−0.6	4.7	4.6	23.1	6.3
West North Central								
MN	40.0	−4.4	15.6	1.6	2.1	5.2	42.3	−2.4
IA	47.7	−4.8	8.9	3.5	1.8	3.2	41.5	−1.9
MO	49.4	−7.2	17.0	−2.8	2.9	12.0	30.7	−2.1
ND	32.6	−5.5	16.0	2.8	4.3	11.5	47.1	−8.9
SD	47.1	−8.0	12.8	−1.2	5.6	17.4	34.5	−8.3
NE	48.6	−7.4	11.7	−1.7	1.8	3.8	37.9	5.2
KS	49.9	−4.4	9.8	−2.4	1.1	3.7	39.2	3.0
South Atlantic								
DE	11.5	0.1	25.3	9.7	2.1	7.5	61.1	−17.3
MD	28.0	−11.7	30.0	−0.7	2.6	9.6	39.4	2.8
VA	43.3	−22.3	23.0	−3.5	3.2	22.8	30.5	3.0
WV	36.0	−13.6	16.2	2.2	20.7	0.5	27.1	10.8
NC	23.1	−10.3	34.8	0.5	4.2	17.8	37.9	−8.1
SC	19.2	−10.4	44.3	−10.5	4.8	28.0	31.7	−7.2
GA	24.5	−12.0	34.4	−11.2	3.8	38.2	37.3	−15.0
FL	25.9	−12.3	39.0	−4.8	2.5	18.7	32.6	−1.6
East South Central								
KY	40.0	−6.4	35.6	−5.9	4.0	13.0	20.3	−0.6
TN	33.4	−10.9	40.4	−11.0	3.4	21.2	22.8	0.7
AL	31.1	−11.3	20.8	−1.1	4.4	24.0	43.7	−11.6
MS	27.5	−11.2	21.4	−8.6	6.0	40.2	45.1	−20.6
West South Central								
AR	23.7	−5.1	22.4	−3.8	3.0	26.4	50.9	−17.4
LA	30.8	−11.7	26.1	−5.4	7.0	32.0	36.0	−14.9
OK	44.5	−4.0	18.8	−6.1	2.9	14.3	33.8	−4.3
TX	46.5	−13.1	17.3	−4.2	4.5	9.9	31.7	7.4
Mountain								
MT	45.8	−13.0	21.8	2.8	4.1	8.5	28.4	1.6
ID	43.3	−14.1	24.3	2.3	7.4	7.9	24.9	4.0
WY	55.3	−10.9	19.2	3.3	5.4	6.3	20.0	1.3
CO	44.0	−8.7	22.2	−2.3	2.1	3.7	31.6	7.3
NM	35.7	−2.6	23.9	−5.6	3.5	8.1	36.9	0.1
AZ	66.5	−28.7	4.6	10.2	1.0	18.0	27.8	0.5
UT	43.7	−18.9	17.9	22.6	8.6	−1.1	29.8	−2.6
NV	46.5	−32.3	13.0	32.2	9.6	2.3	30.8	−2.0
Pacific								
WA	51.0	−14.5	11.0	4.7	4.7	4.0	33.2	5.9
OR	41.7	−14.5	33.0	−0.2	2.4	9.9	22.8	4.8
CA	55.4	−9.0	10.9	12.5	1.0	6.2	32.9	−9.9
United States	43.3	−9.5	18.8	0.0	3.3	10.5	34.5	−1.0

[a]Percentage may not sum to 100 and net changes to zero due to rounding.

[b]Includes the Federal Intermediate Credit Bank, the Commodity Credit Corporation, and individuals and others.

Source: Amols and Kaiser.

in commercial bank market share can be expressed as

$$dMS/MS = d(ALDR)/ALDR + d(BD)/BD - d(TAL)/TAL, \quad (3)$$

where the first term on the right-hand side is the percentage change in the agricultural loan-to-deposit ratio (portfolio decisions), the second is the percentage change in bank deposits (loanable funds availability), and the third term represents the percentage change in total agricultural lending in the state (loan market size).

Table 2 presents empirical measures of the three components for the forty-eight contiguous states. The portfolio, loanable funds, and loan market size components of changes in market shares varied greatly among the states, and the variation in the signs and magnitude of the portfolio effects are particularly notable. For example, among three southwestern states (Texas, New Mexico, Arizona) the percentage change in commercial bank nonreal estate agricultural loan-to-deposit ratios (*PCALDR*) decreased markedly, ranging from −37.6 percent to −54.5 percent. Alternatively, in the east north central region (Ohio, Indiana, Illinois, Michigan, Wisconsin), *PCALDR* varied from +13.1 percent to +43.7 percent.

The second component, percentage change in loanable funds (*PCBD*), represents a proxy for economic growth in the state. The Sunbelt states such as Arizona, New Mexico, Oklahoma, and Texas experienced dramatic increases in bank deposits during the study period. Little growth in the loanable funds component was evident in the older industrial states such as Ohio, Michigan, New York, and New Jersey.

The third dependent variable, loan market size (*PCTAL*), captures the lending activities of alternative sources of nonreal estate credit. Major market size expansions in California, Georgia, Louisiana, Michigan, Mississippi, and North Dakota can be attributed to increased lending by the FCS and/or the FmHA. As anticipated, market size expansions were very limited in the relatively nonagricultural states, such as Maine, New Jersey, New Mexico, and West Virginia.

The three components interact to determine the percentage change in commercial bank market shares for the study period. For example, the increase in market share by commercial banks in Massachusetts came largely from the change in the portfolio decisions component (142.1 percent). However in the case of Oklahoma, the dramatic increase in loanable funds (104.3 percent) contributed more to the change in market share than portfolio decisions and the loan market size effect. A final example is North Dakota, which experienced an increase in FCS and FmHA loan activity between 1969 and 1982. Based on the relationships modeled in equation 3, the increased loan activity by specialized lenders was the principal contributing factor in the reduction of market shares in that state. In the following section, the relationship between state characteristics and the changes in the market share components will be estimated.

Analysis

Theoretical discussions of banking behavior have used mean-variance and expected utility of profit models to analyze portfolio management decisions (Santomero; Elyasiani; Mason). In the agricultural economics literature, Robison and Barry have modeled bank portfolio adjustments due to shifts in risk-free wealth, changes in the probability distribution of returns, and alternative risk preference assumptions. In general, those models indicate that loan demand levels and demand elasticities determine interest rates and rates of returns on loans. Relative differences in risk between bank assets (e.g., farm versus nonfarm loans) influence the direction and magnitude of the adjustments in the lender's portfolio. The risk attitudes of loan officers and bank management influence portfolio decisions and overall loan volume. Also, the structure of the banking system (e.g., unit versus statewide or limited branching) may be an important variable in determining the level of competition for both deposits and loans, and possibly the bank's level of commitment to the agricultural sector.

To test the hypothetical relationships for empirical validity, a set of twenty-four measures or variables were selected from

Table 2. Percentage Change in Market Share Components by State, 1969–82

State	Dependent Variables		
	Portfolio Decisions (*PCALDR*)	Loanable Funds (*PCBD*)	Loan Market Size (*PCTAL*)
AL	−18.9	48.0	88.9
AZ	−54.5	71.4	37.0
AR	−22.7	62.0	59.6
CA	14.3	51.2	106.7
CO	−36.5	64.0	29.7
CT	13.6	12.5	45.1
DE	9.4	64.0	77.3
FL	−51.0	59.1	48.6
GA	−19.2	38.2	118.4
ID	−19.1	55.2	86.4
IL	16.5	18.0	71.2
IN	21.1	17.1	97.3
IA	6.9	38.6	64.9
KS	−3.6	42.0	49.9
KY	.1	52.9	82.4
LA	−9.9	76.3	156.5
ME	−62.4	13.8	3.6
MD	−39.5	27.1	32.4
MA	142.1	7.6	67.8
MI	13.1	−4.5	102.9
MN	32.8	33.9	99.8
MS	−10.7	60.3	141.6
MO	21.6	15.5	64.1
MT	−13.7	41.7	70.3
NE	18.4	36.9	91.1
NV	−63.0	56.8	90.3
NH	−88.1	67.1	90.2
NJ	−78.1	.5	9.2
NM	−49.2	103.3	9.5
NY	93.5	.4	79.8
NC	−22.0	35.1	89.8
ND	17.7	51.3	113.8
OH	24.7	−7.0	73.5
OK	−22.4	104.3	74.2
OR	−19.4	22.4	51.4
PA	−24.9	12.2	46.8
RI	−78.0	70.4	29.2
SC	−43.1	54.3	90.9
SD	−13.3	85.4	68.9
TN	−17.8	38.2	93.3
TX	−37.6	101.8	75.3
UT	−52.0	56.7	32.2
VT	−41.3	29.0	13.8
VA	−36.9	34.4	75.2
WA	−12.4	51.9	86.2
WV	−55.8	58.6	12.6
WI	43.7	11.0	116.7
WY	−40.7	92.7	42.3

secondary sources. The independent variables for 1969–82, unless otherwise specified, are listed in Table 3 (U.S. Department of Commerce; Rand McNally; Krause). All dollar values or percentage changes based on dollar figures are real values (1982 = 100). The twenty-four variables are state specific and represent measures or proxies for factors that could explain state-by-state differences in market shares. Variables selected to explain changes in the demand for nonreal estate agricultural loans include: percentage change in farm income, farm size, farm

Table 3. Independent Variables and Rotated Component Loadings Using Factor Analysis

Variable (Names)	Factor 1	2	3	4
Percentage Change in Nonfarm Income (*PCNFY*)	.882	.115	.154	.157
Percentage Change in Manufacturing Employment (*PCME*)	.812	.222	.032	.138
Average Farm Size, 1969 (*SIZE*69)	.803	.213	−.296	.150
Average Farm Size (*AVSIZE*)	.801	.239	−.284	.150
Average Farm Size, 1982 (*SIZE*82)	.789	.287	−.277	.163
Percent of Acreage Controlled by Corp., 1978 (*CORP*1)	.782	−.027	−.463	−.148
Percent of Farm Sales by Corporations, 1978 (*CORP*2)	.760	−.119	−.269	−.313
Irrigated Acres as a % of Tot. Crop Acres, 1978 (*IRRG*)	.723	−.140	−.091	−.176
Coefficient of Variation in Nonfarm Income (*CVNFY*)	.698	−.137	.037	.013
Percent of Farms Which Are Corporations, 1978 (*CORP*3)	.608	−.103	−.667	−.155
Percentage Change in Farm Size (*PCSIZE*)	−.585	.288	.517	.065
Percentage Change in Farm Numbers (*PCFN*)	.553	−.223	−.519	−.084
Percent Farms with Gross Sales <$10,000, 1978 (*SALES*1)	.051	−.876	.056	.286
Ratio of Avg. Farm Pop. to Nonfarm Pop. (*POP*)	−.129	.838	.235	.069
Coefficient of Variation in Farm Income (*CVFY*)	.033	.756	.202	.322
Mean Unemployment Rate (*EMPLOY*)	−.093	−.702	−.335	−.006
Standard Deviation in the Unemployment Rate (*SDEMPLOY*)	−.232	−.625	.111	.322
Number of Farms, 1978 (*FARMS*)	−.204	.135	.815	−.194
Bank Structure, 1978 (1 = Branch, 0 = Other) (*BANK*)	−.008	−.011	−.710	−.232
Number of PCA Offices, 1982 (*PCA*)	−.123	.197	.706	−.452
Percentage Change in Farm Income (*PCFY*)	.043	−.123	.183	−.790
Percentage Change in Value of Land and Bldgs. (*PCVAL*)	.424	.075	.221	.534
Pct. of Farms with Gross Sales <$100,000, 1978 (*SALES*2)	−.241	−.405	.400	.499
Percentage Change in Service Employment (*PCSE*)	−.019	.499	.015	.063

Sources: U.S. Department of Commerce, various years; Rand McNally; Krause.

numbers, and irrigated acreage and percent of farms with gross sales of less than $100,000. The demand for nonagricultural loans is captured by the following measures: percentage change in nonfarm income, percentage change in manufacturing and service employment, and the unemployment rate. Those variables are demand shifters. Interest rates were not included because it was assumed that the FCS, FmHA and other lenders' credit policies were managed relatively uniformly across states and that capital markets were spatially efficient during the study period.[1]

[1]Interest rate differentials resulting from macroeconomic, policy level changes may affect market shares at the national level. However, those changes would not show up in interstate interest differentials, and, thus, are not relevant for interstate comparisons. Secondly, it is recognized that interstate differentials in interest rates would occur as a result of interstate differences in fluctuations in the demand for agricultural and nonagricultural loans. However, assuming efficiency in the money markets, the differences would be relatively short-lived, and not relevant to the historical analysis. Finally, even with a relaxation of the efficiency assumption, we believe our income and risk variables in the model would be strongly correlated with interest rate differentials, thereby already capturing a possible interest rate effect.

Risk variables include the coefficient of variation in farm and nonfarm income. Bank structure (either branch or other form), the number of PCA offices in the state, and the ratio of farm to nonfarm population were selected as structural variables.

Two types of analyses were performed on the data. First, factor analysis was used to explore the differences between the structural factors that also show some association with the dependent variables: PCALDR, PCBD, and PCTAL (Gorsuch). The critical question to address was, is there a measurable set of differences in structural variables across states? Factor analysis assists in the process by providing a structure to the chosen independent variables. Mathematically, factor analysis attempts to distinguish between clusters of vectors associated with the independent variables. By generating factors, the large number of potential, structural variables can be reduced in number, thereby reducing multicollinearity, while maintaining the amount of information contained in all the variables in the analysis. In this research, factor analysis grouped or clustered the twenty-four proxy variables into groups of uncorrelated state characteristics. The independent variables were factor analyzed using the varimax rotation and a critical eigenvalue of 0.

Surrogate variables were selected from each significant grouping for each factor (Table 3). *PCNFY, POP, BANK,* and *PCFY* were chosen from factors 1–4 respectively. *PCVAL* and the two risk variables (*CVNFY* and *CVFY*), three measures with high factor loadings, were also selected in order to test the hypotheses proposed by earlier authors. The equations estimated using OLS are

$$PCALDR_i = b_0 + b_1 PCNFY + b_2 PCFY + b_3 RISK + b_4 BANK + b_5 POP + e_i, \quad (4)$$

$$PCBD_i = b_0 + b_1 PCNFY + b_2 PCFY + b_3 BANK + b_4 POP + e_i, \quad (5)$$

$$PCTAL_i = b_0 + b_1 PCFY + b_2 BANK + b_3 POP + b_4 PCSIZE + b_5 PCVAL + e_i, \quad (6)$$

where *RISK*, the ratio of the coefficient of variation in nonfarm income (*CVNFY*) to farm income (*CVFY*), is the relative difference between risk in the state's nonfarm and farm sectors. Percentage changes in farm income (*PCFY*) and nonfarm income (*PCNFY*) represent demand shifters in equations 4 and 5, and *POP* (ratio of farm to nonfarm population) is a cross-sectional variable capturing the relative importance of agriculture in each state. Further changes in the state's agricultural sector are reflected by percentage change in farm size (*PCSIZE*) and percentage change in value of land and buildings (*PCVAL*). Finally, *BANK* is a dummy variable for the state's banking structure (1 = Branch, 0 = Other) and e_i is the error term.

Summary of Findings

Results of the regression analysis indicate that increases in nonfarm income had a statistically significant relationship to the percentage change in the agricultural loan-to-deposit ratios and commercial bank deposits across states (Table 4). In the former case the impact is negative, while in the latter case nonfarm economic activity has a positive correlation. Increased aggregate economic activity in the state draws funds, through portfolio decisions, away from the agricultural sector. Nevada and Arizona are examples of states where that phenomenon occurred during the study period. This statistical result lends support to Calvert and Meltzer's claim concerning the inverse relationship between commercial bank market shares in agriculture and aggregate economic activity. The second point is that greater nonfarm prosperity significantly increases bank deposits and, hence, the funds available for agricultural as well as other types of lending. Of course, bank management will decide whether or not some percentage of the additional resources are allocated to agricultural lending.

Increases in farm income had positive, but statistically insignificant, impacts on the agricultural loan-to-deposit ratio and the percentage change in bank deposits. The findings indicate that farm prosperity had an insignificant impact on portfolio decisions and the aggregate level of loanable funds available to the public. Farm income, however, was significant in

Table 4. Regression Results

	Dependent Variables		
	PCALDR	*PCBD*	*PCTAL*
CONSTANT	.218	.050	.574*
	(.192)	(.082)	(.130)
PCNFY	−.753*	.756*	
	(.183)	(.101)	
PCFY	.253	.040	.537*
	(.223)	(.120)	(.174)
RISK	.878		
	(.729)		
BANK	−.229*	−.008	−.065
	(.104)	(.058)	(.088)
POP	2.133*	.601	.118
	(1.167)	(.585)	(.895)
PCSIZE			1.734*
			(.328)
PCVAL			.256*
			(.149)
R^2	.39	.57	.51
F	5.28	14.36	8.83

Standard errors are in parentheses below the coefficients.

*One-tailed *t*-tests were significant at the .10 level of confidence.

explaining changes in total agricultural loans. Relatively higher farm incomes increased the borrowing in the states that produce high value crops (e.g., California) and in states where the agricultural sector is an important part of the state's economy (e.g., Wisconsin, North Dakota).

Variability in farm income in most states, measured using a coefficient of variation, was significantly greater than variability in nonfarm income during the study period. However, this relative measure of income variability (*RISK*) does not appear to be statistically significant in the model. The hypothesis was that the agricultural loan-to-deposit ratio would increase as *RISK* increased. Although the sign on the risk coefficient is positive as hypothesized, the coefficient is not statistically significant. Expected loan demand appears to have impacted more on portfolio decision making than the potential default rates associated with industrial, commercial, and consumer loans relative to the risks in agricultural lending. Commercial banks may not have allocated funds away from agricultural lending during most of the period due to the relative stability and slight upward trend of farm incomes, holding all other factors constant.

The bank structure variable is statistically significant in the portfolio equation but not in the bank deposit and total agricultural loans equations. Commercial banks in unit or limited branching states increased (or decreased less) their agricultural loan-to-deposit ratios more than states with statewide branching. Alternatively, banks in branch banking states adjusted their loan portfolios to a greater extent towards nonfarm lending activities during 1969–82. Although the authors recognize the changes in bank structure in some states between 1978 and 1982 (e.g., towards multibank holding companies), the findings do provide empirical support for the earlier hypotheses of Melichar (1975) and Benjamin.

The demographic composition of the state (*POP*) is significant in explaining portfolio decisions. States with relatively large farm populations (e.g., Iowa and Kansas) experienced greater relative growth (or relatively smaller reductions) in agricultural loan-to-deposit ratios. Bank officers and loan committees made decisions to support

agricultural production in those states. However, larger rural populations did not significantly influence changes in bank deposits or total agricultural loans.

Changes in farm size (*PCSIZE*) and farm value (*PCVAL*) are positively related to changes in total agricultural loans. The relationships reflect the additional investments in agriculture during the 1970s and early 1980s, particularly in important Midwestern states (e.g., Indiana and Illinois). Although the variables measure changes attributable to real estate and fixed asset (e.g., building) purchases, additional nonreal estate lending was necessary to operate more acres of production. Machinery purchases are captured in the nonreal estate loan figures.

The above findings indicate that changes in market shares were influenced by state characteristics during 1969–82. Since 1982, the agricultural finance sector has experienced significant economic stress, both at the producer and lender levels. However, the nonagricultural economy has recovered from a recession during this period. In order to validate the earlier statistical results on a later period, the portfolio equation (*PCALDR*) was estimated using 1983–85 data (USDA 1986a). The results (with standard errors in parentheses) are

$$\begin{aligned} PCALDR = {} & -0.067 - 1.928\ PCNFY \\ & \quad (0.051) \quad (0.579) \\ & -0.001\ PCFY + 0.106\ RISK \\ & \quad (0.002) \quad\quad (0.063) \\ & -0.009\ BANK - 0.011\ POP, \\ & \quad (0.034) \quad\quad (0.416) \\ & R^2 = .26 \qquad F = 3.02 \end{aligned} \tag{7}$$

which reveal that strong, nonfarm economic growth continued to encourage banks to allocate funds away from the agricultural sector. Percentage change in farm income and bank structure are not statistically significant measures for delineating changes in agricultural loan-to-deposit ratios. Possibly the results can be attributed to few dramatic changes in farm income over the three-year period and the recent growth in the number of multibank holding companies in unit banking states. Not surprisingly *RISK* is a statistically significant variable for the more recent time period. Lower variability in nonfarm income relative to farm income encouraged a shift to commercial, industrial, and consumer lending by commercial banks. If the uncertainty continues in agriculture, commercial banks may continue to shift their portfolios to relatively less risky assets. The action would place a greater responsibility on the FCS and FmHA to finance agricultural borrowing in many states.

Concluding Remarks

Three important policy implications concerning agricultural credit evolve from this study. First, nonfarm economic activity can be perceived as both a blessing and a curse. Commercial and industrial growth does increase the availability of total loan funds, which may increase the supply of credit for agricultural borrowers. Risk attitudes and the commitment of a bank's management and stockholders to agriculture may determine if a proportion of those additional funds are made available for agricultural loans. However, the downside for the agricultural sector, primarily in statewide branching states, is that banks will shift their loan portfolio towards nonfarm loans as economic activity increases in the nonagricultural sectors. In general, the downside movement occurred to the greatest extent in the less dominant agricultural states in the country (e.g., Maine, Nevada, New Hampshire, New Jersey, and Rhode Island).

A second implication is that bank structure was found to be important in determining the movement of loan funds between economic sectors and industries. Agricultural lending levels for commercial banks adjusted downward to a lesser extent in unit and limited branch banking states between 1969 and 1982. However, banks in those states (e.g., Iowa, Minnesota, North Dakota, Nebraska, Oklahoma, Texas) experienced the highest levels of financial stress during the 1980s (Melichar 1987). Commercial banks in statewide branching states reduced their loan exposure to the agricultural sector in a statistically significant manner during the study period. Commercial, industrial, and consumer lending represented less risk to the banker relative to the variability associated with agricultural loans.

Finally, regression results from 1983–85 indicate that relative risk between bank assets may encourage a further decline in commercial bank activity in agricultural lending. Banks have more flexibility in the management of their loan portfolios than do specialized agricultural lenders. Combined with the bank structure results, the findings imply that further expansion of intra and interstate branch banking would contribute to additional adjustments by commercial banks towards more nonfarm lending. The severity of the trend varies across states and reflects the diversity in agricultural lending in this country. Recent market share data for some states do indicate a slight increase in commercial bank shares in agricultural lending due to higher farm incomes, financial pressures on the FCS and FmHA, and a lower cost of funds for banks relative to specialized lenders. Nevertheless, if the general trends identified in this analysis continue, a permanent movement by commercial banks away from agricultural lending would have significant state, regional, and national implications for the future supply, and terms, of credit to the agricultural sector.

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Predicting Probability of Loan Default

Timothy Mortensen, David L. Watt, and F. Larry Leistritz

Abstract

A model demonstrating the estimation of crucial financial characteristics of farmers that determine loan delinquency is developed using a multivariate logistic regression model. The model is then used in conjunction with a loan-pricing model to determine the optimum breaking point where lender revenue is maximized. Results indicate that debt-to-asset ratio and the operating ratio are most indicative of loan default for the population surveyed.

Key words: farm, financial, logistic regression, loan delinquency.

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Deterioration of the financial condition of farm operators has been the topic of news reports and research efforts for some time (Lines and Morehart; Johnson et al.; and Melichar, among others). The Wisconsin Agricultural Reporting Service, based on a survey of nine midwestern states, reported that 10.3 percent and 12.3 percent of the farmers surveyed were delinquent on real estate and nonreal estate loans, respectively. Jurenas reports that 77,000 farm operators experiencing extreme financial stress owe lenders almost $24 billion. Farm financial problems have impacted lenders. They have been faced with growth in agricultural credit demand, with increased use of national credit markets (which exposed them to volatile interest rates in the 1980s), and with deteriorating credit worthiness of some farm borrowers.

Probit and discriminant analyses have been used to classify farm borrowers as good or poor risks (Luftburrow et al.; Pederson and Duncan, respectively). Luftburrow et al. found liquidity, leverage, collateral, cash flow, and repayment history to be significant determinants for classifying borrowers. Pederson and Duncan reported that debt-to-asset ratio and total acres farmed were significant in their discriminant model. Fiske et al. employed logistic regression and found that leverage, experience, interest rate, and percent of real estate assets were factors influencing currentness of debt payments of Ohio farmers.

The purpose of this paper is to demonstrate a model estimating crucial predictors of loan defaults. Sample data are used to identify significant determinants of the debt payment status of North Dakota farmers. Selected determinants are then used to model the probability of loan default. In conjunction with a loan-pricing model

specific to the lender, the data are used to demonstrate the calculation of a breaking point (*PPROB*) that maximizes revenue to the lending institutions.

Data and Study Procedures

Data from longitudinal, cross-sectional surveys of 763 farm operators representative of North Dakota were used to demonstrate the technique. Farmers were less than sixty-five years old, and they considered farming their primary occupation (Leistritz et al.).

Measures taken from farmers' responses to questions on the surveys were used as determinants of solvency and performance of the farm business. They were hypothesized as being directly or indirectly related to farm financial stress.

Farm operators were categorized as current on annual debt obligations if all principal and interest had been paid (or debt had been renegotiated) on January 1, 1986. The dependent variable in the regression model, *CURRENT*, equals 0 if a farm operator was current on debt payments and equals 1 if the operator was delinquent.

Debt payment status on January 1, 1986, is the result of the solvency position of the business on January 1, 1985, performance during 1985, and other socioeconomic measures of the operator. Most explanatory variables are ratios representing profitability and liquidity for 1985, and leverage on January 1, 1985. Absolute dollar measures and other socioeconomic variables thought to be useful as determinants of debt payment status also are tested in the analysis. Limitations are inherent in the surveys, and not all measures are available for exploration. The variables studied and tested for significance were age of the operator, years of farming experience, ratio of rented acres to total acres, gross cash farm income for 1985, net cash farm income for 1985, net cash income/gross cash farm income, production expenses/gross cash farm income, net cash farm income/persons in household, viability,[1] net cash income/total assets, interest paid/gross cash farm income, current debts/current assets, nonfarm income/total debt, debt-to-asset ratio at beginning of year, and total debt/total acres farmed.

A decision to lend money to a farm operator is normally based on solvency of the business at the time of loan application and on other factors such as farm profitability in past years and expected performance in the upcoming crop year. Returns deviate from their expected value due to variations in profit derived from production activities. This means that operators, in years of low returns, may not generate sufficient cash flow to meet debt service obligations.

The intent of the model is to determine those variables that, when applied in combination with the operator's solvency status on January 1, 1985, would be statistically significant indicators of expected debt payment status at the end of the operating year. Ideally, to test for such indicators at the time a loan decision is made, previous years' data from a lending institution are necessary. The types of data useful for analysis include but are not limited to debts, assets, net cash income, gross income, interest paid, productivity, and repayment history. Since data of that nature were not directly available, this analysis makes use of cross-sectional, longitudinal survey data.

Methods

Application of linear regression models when the dependent variable is binary (0 or 1) in nature is complex and involves use of binary choice models (Pindyck and Rubinfeld; Press and Wilson). A desirable characteristic of a model is its ability to predict whether a farm operator is current or delinquent given attributes of that particular operator. A logit model has that characteristic and was used to estimate the bivariate events (current or delinquent). The cumulative logistic probability function is specified as

$$P_i = F(Z_i) = F(a + bX_i) = 1/1 + e^{-zi}. \quad (1)$$

[1]Viability is defined as net cash income and intermediate debt payment and other income divided by family living allowance and long-term debt payment.

Where

P_i = probability of dependent variable, $(Y_i) = 1$,
$Z_i = a + bX_i$,
X_i = attribute of individual i,
e = base of the natural logarithm,
a = intercept parameter,
b = parameter associated with attribute X_i.

In the binomial case, the probability of one choice is P_i, and the probability of the only other choice is $1 - P_i$. The logit model is further derived as follows:

$$(1 + e^{-Z_i})P_i = 1, \tag{2}$$

$$\ln (P_i/1 - P_i) = Z_i = a + bX_i \tag{3}$$

The value of the index (Z_i) also may be expanded to multivariate cases where a number of explanatory variables are used. Z_i becomes a linear combination of independent variables such that

$$Z_i = a + b_1X_1 + b_2X_2 + \ldots + b_nX_n + E_i \tag{4}$$

Z_i takes the role of a breaking point (Z_i^*) where

$$Y_i = 0 \text{ when } Z_i \leq Z_i^*, \text{ and}$$
$$Y_i = 1 \text{ when } Z_i > Z_i^*. \tag{5}$$

Care must be taken in interpreting results using equation 3. Z_i is the natural log of the probability of occurrence of a certain event, not the probability directly, and e^{Z_i} gives the probability of the event occurring.

The logit model has several desirable characteristics: (*a*) the probability is bounded by 0 and 1; (*b*) the concept of a breaking point is maintained; and (*c*) while the magnitude of a logit coefficient is irrelevant, it is possible to rank the coefficients and say that a coefficient has a greater effect on probability than those ranked below it (see Press and Wilson). Data are analyzed using the LOGIST procedure (Harrell) on the Statistical Analysis System (SAS).

Optimization of the classification table. LOGIST software provides a classification table showing how the model classified each observation. Figure 1 shows an example of the number of actual and predicted current and delinquent observations. In the example, the actual percentage of correct classifications may be very high (e.g., 80 percent). However, when the payoffs for observations in each of the four cells are not equal, accuracy may not be optimum. In this case, the actual delinquent observations that are predicted current are troublesome. In this example no actual delinquent observations were predicted as delinquent. Depending on the importance of actual delinquent observations and because delinquent loans are very expensive to banks, the percent of correctly classified predictions may not be the best criterion for achieving profit maximization. That is demonstrated later.

Fiske et al. reported that their two model specifications correctly classified 78 and 76 percent of the observations, respectively. They did not indicate how many actual delinquent observations were predicted delinquent. If a lender were to use the example model to classify potential borrowers, every borrower would be granted a loan; and an 80 percent accuracy rate could cause financial stress for the bank.

The LOGIST option *PPROB* defines the breaking point probability threshold. While the default setting of *PPROB* for classifying observations as current or delinquent is .500, the user may respecify that setting. Observations having a probability (P_i) greater than *PPROB* are classified delinquent and observations having a probability of less than *PPROB* are classified

Figure 1. Classification Table

		PREDICTED	
		CURRENT	DELINQUENT
ACTUAL	CURRENT	200 QUADRANT I	0 QUADRANT II
	DELINQUENT	50 QUADRANT III	0 QUADRANT IV

PERCENT CORRECT = 80.0

current. The problem of misclassification becomes apparent when consequences of being classified in one of four quadrants are not equal as would be the case for a lending institution.

From a lender's perspective, an institution would be exposed to the greatest potential loss by farm operators who were predicted to remain current on debt obligations but who actually default. The objective, then, is to maximize economic return to a lending institution using the model.

Saxowsky et al. reported a loan pricing model where interest income from loans is equated with costs. The equation is shown as

$$LY = I + L + O + E - S - F - DY + r, \quad (6)$$

Where

LY = interest income from loans not in default,
I = interest costs,
L = provisions for loan losses,
O = operating expenses,
E = earnings for building reserves,
S = income from securities,
F = fees and other income,
DY = interest income from loans in default,
r = risk premium.

Lending institutions derive income (LY), (DY), (S), and (F). Costs are incurred by (I), (L), and (O). These may be expressed as cost of funds (COF) shown as

$$COF = I\,(\text{average interest paid}) + O + L. \quad (7)$$

Moving income items to and subtracting COF from the left side results in the following equation:

$$LY + S + F + DY - COF = E + r. \quad (8)$$

Equation 8 is used for illustrative purposes in optimizing the classification table. Simplifying assumptions concerning a lending institution include

1. An institution has two alternatives for investment of deposits: (a) lend money to individuals or businesses for various purposes or (b) invest in government or other securities. No preference is shown as to the proportion of funds used for either choice. Securities are considered risk-free investments (for simplicity); therefore, r is zero when that choice is made.

2. Principal, but no interest, is recovered from loans granted that eventually default (DY is zero).

3. Service fees (F) are assumed constant and so are not included in calculations.

Funds invested in securities (S) less cost of funds (COF) equal earnings for building reserves (E). This may be considered "normal" profit. Funds loaned to individuals or businesses (LY) less cost of funds (COF) equal (E) plus a premium for added default and business risk (r).

$$S - COF = E, \text{ and} \quad (9)$$

$$LY - COF = E + r. \quad (10)$$

An interest rate of 11 percent and a cost of funds (COF) of 9.5 percent are used for illustration in calculating an optimum loan decision breaking point ($PPROB$). Return from loaned funds ($E + r$), becomes 1.5 percent, and considering (r) as 1 percent, return on security investment is .5 percent. The values are used in the classification table to illustrate setting $PPROB$ for optimizing returns. Values used in the illustration may be adjusted to fit individual lender situations.

Observations properly classified in quadrant one (Figure 1) are borrowers that were correctly predicted as current and actually did not default. Revenue derived from loans in the quadrant includes E and r or 1.5 percent over cost of funds (COF).

Observations in quadrant two are actual current borrowers, which the model predicted as delinquent. The model incorrectly classified potential borrowers as delinquent in this quadrant. Funds not loaned to individuals or businesses are invested in securities and earn a positive return of .5 percent.

Quadrant four contains delinquent borrowers predicted to be delinquent. They are correctly classified, and a lender also would invest funds in securities, earning .5 percent above the cost of funds.

Quadrant three contains the borrowers who were predicted current but actually defaulted. If collateral is sufficient to cover principal and recovery costs, a lender could potentially lose interest income (see assumptions) from borrowers who defaulted and never paid. For illustration, losing interest (not principal) on loans is the cost of loan default. Delinquent loan losses vary among institutions, and the average loss is unknown. An institution using this model could use either their historic values or an estimate of future impacts of loan default. In this example, if the interest rate charged on a loan is 11 percent and the overall cost of funds (*COF*) is 9.5 percent, the lender is penalized and will lose 9.5 percent interest income on misclassified borrowers in quadrant three.

The objective is to find the *PPROB* that maximizes lender earnings. This is accomplished using a tabular method of comparison as *PPROB* is reduced over a relevant range. Potential borrowers in quadrants one and three receive loans based on their respective percent of total customers. The remaining potential loan applicants are rejected, and funds are invested in securities, assuming that no other customers are available for loan processing.

As *PPROB* is reduced, potential borrowers classified in quadrants one and three are reclassified into quadrants two and four, respectively. The optimum *PPROB* is reached when the sum of revenue from the four quadrants is maximized. Results derived from this analysis are presented below.

Results

Selection of variables. Beginning with the candidate variables regression LOGIST was used to analyze multivariate models for the most revealing determinants of financial stress. Variables that were logically correlated (e.g., interest paid and interest-to-gross income ratio) were not included simultaneously in a LOGIST model. Debt-to-asset ratio, which was highly significant (chi-square = 34.29) when used alone, was included in all models tested.

Criteria used to select the best model were (*a*) the model with the highest overall chi-square statistic significant at .10, (*b*) the model with the highest rho-square (pseudo-R square), and (*c*) the model with the highest correctly classified observations.

Model results. The model selected includes the debt-to-asset ratio in 1985 (*DA*) and the operating ratio (*OP*) to predict probability of loan default and is shown as

$$Z_i = \ln P/1 - P = \underset{(52.4)}{-5.67} + \underset{(31.4)}{3.86\,DA} + \underset{(10.2)}{1.99\,OP}.$$

This model had a chi-square statistic of 51.5; significant at the 1 percent level. Individual chi-square statistics are shown in parentheses; all are statistically significant at the 1 percent level. Signs associated with individual parameters are correct according to economic theory. As both debt-to-asset and operating ratios increase, the probability of an individual being delinquent also increases.

The model correctly classified 88.2 percent of the observations with *PPROB* at 0.5 (Figure 2). Attempts to specify a model with more than two variables were not

Figure 2. Classification Table Results with PPROB at .5 (Results when PPROB is .18 are in parentheses)

ACTUAL	PREDICTED: CURRENT	PREDICTED: DELINQUENT
CURRENT	I: 338 (280)	II: 4 (62)
DELINQUENT	III: 42 (16)	IV: 7 (33)

PERCENT CORRECT = 88.2 (80.1)

successful at the 10 percent level of significance.

Maximizing lender revenue. The model selected was evaluated for sensitivity of the percentage correctly classified and the number of loans written when *PPROB* was varied from .095 to .5 (Figure 3). Percent of loans written includes the actual current and the predicted current from the classification tables. The percent correct is the actual current and the predicted delinquent from the classification table. Percent of loans granted declines as *PPROB* is adjusted downward.

Calculations for maximizing net income are shown in Figure 4. Maximum net revenue occurred at a *PPROB* of .18 where slightly more than 80 percent of the observations were correctly classified.

The resulting values for the classification matrix are shown in parentheses in Figure 2; 280 borrowers (71.6 percent) are classified correctly as remaining current on debt payments. Thirty-three borrowers (8.4 percent) are correctly classified as delinquent (i.e., they defaulted on loans). Nearly 16 percent (62 observations) were incorrectly predicted as delinquent, and only 4.1 percent (16) were incorrectly classified as current.

Solution of model. The specified model may be used to calculate the probability of a farm operator being delinquent on debt payments. Evaluating both variables at their sample means (.354 for *DA* and .940 for *OP*), the solution is as follows:

$$\ln P/1 - P = -5.67 + 3.86\,(.354) + 1.99\,(.940),$$

$$\ln P/1 - P = -2.433.$$

Solving this equation, $P = .081$. This indicates that for an average farm operator with a debt-to-asset ratio of .354 and an operating ratio of .940 the probability of being delinquent is 8.1 percent.

Varying the debt-to-asset ratio while holding the operating ratio at its mean is shown in Figure 5. The function exhibits the theoretical shape of the cumulative logistic probability function. Similar results can be derived for the operating ratio when debt-to-asset ratio is held at its mean.

Figure 3. Percent Observations Classified Correctly and Percent Loans Written as PPROB is Adjusted

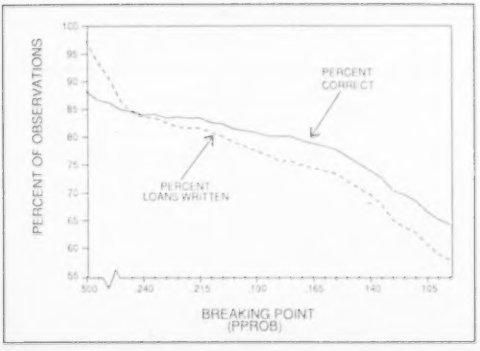


Figure 4. Interest Revenue to a Lender as PPROB is Adjusted

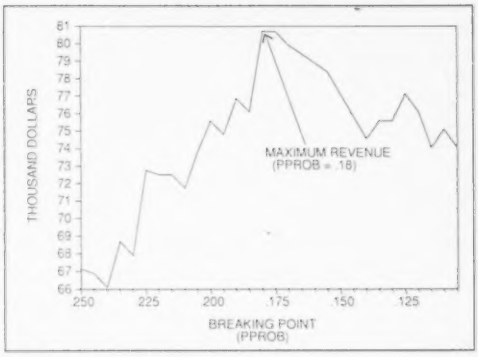
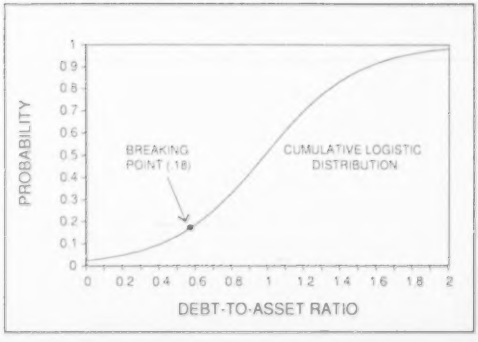


Figure 5. Probability of Being Delinquent Holding Operating Ratio at Its Mean



The model may be solved to reveal the debt-to-asset ratio required to reach the *PPROB* of .18 by holding *OP* at its mean and solving for *DA*. The model is solved for *DA* using $P = .18$.

$$
\begin{aligned}
P/1 - P &= e^{Zi}, \\
\ln .2195 &= Zi, \\
\ln .2195 &= -5.67 + 3.86\,DA \\
&\quad + 1.99\,(.940), \\
DA &= .591.
\end{aligned}
$$

A debt-to-asset ratio of .59 is the threshold value where an individual has an 18 percent probability of being delinquent, given an operating ratio of .940.

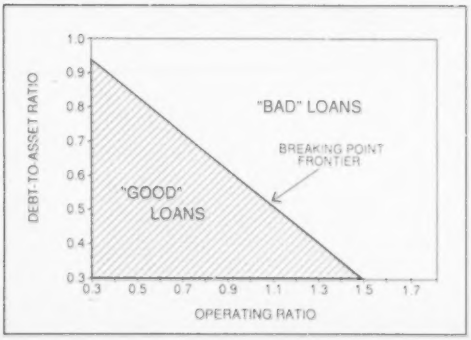
Figure 6 explicitly illustrates the possible combinations of debt-to-asset ratio and operating ratio possible to reach the breaking point frontier of .18. It is obvious that more profitable operations are able to carry more debt.

Models containing other variables also were significant, but chi-square statistics were lower than for the one discussed above. Viability and return on assets, when combined separately with debt-to-asset ratio, revealed model chi-square statistics of 38.2 and 41.1, respectively.

Summary

The results of using logistic regression as a tool for classifying farm loan applications as current or delinquent appear promising. The model correctly classified 88.2 percent of the borrowers at a breaking point of .5.

Figure 6. Values of Debt-to-Asset Ratio and Operating Ratio to Reach the Breaking Point Frontier



The classification of borrowers can be further enhanced by applying the loan pricing model and adjusting the breaking point to maximize profit to a lending institution.

When the breaking point was adjusted downward, borrowers were reclassified among quadrants in the classification table. The resulting 80 percent accuracy rate maximized profit to a lending institution. Some borrowers (16 percent) were predicted delinquent even though they did not eventually default on their obligations. The rejection of "good" borrowers is unavoidable in most situations, even using subjective analysis of loan applicants. The intent is to combine significant variables in an objective analysis of loan applications and to use it as at least a partial guide for basing loan decisions.

Perhaps the most serious limitation of this study was that farms are not homogeneous. Farm types, climate, and soil characteristics vary widely from farm operations exclusively growing small grains or row crops to various livestock operations. Performance of farms can vary greatly under dissimilar conditions.

Profitability, management ability, and efficiency all vary not only among farm operators but among farm types and geographic regions as well. Asset valuations and inventory changes may be inconsistent among operators answering survey questions. Therefore, return-to-equity and return-to-asset ratios cannot be calculated with accuracy. The model confirms, however, that profitability and solvency remain important determinants of successful farm borrowing.

Potential users of the model described here should use historic data from individual borrowers characteristic of their market area; that would localize weather, soil properties, and farming practices. An institution would tailor the model to its situation. Under the controlled local environment, a greater number of borrower attributes would probably become apparent and could be combined with the subjective judgment of the loan officer in the loan decision process.

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An Analysis of Debt Financing in U.S. Agriculture

Fred C. White and Syu-Jyun Larry Lyu

Abstract

For almost half a century, debt and equity levels in U.S. agriculture had mounted. Then in the 1980s agriculture's financial structure was adjusted significantly. This study analyzes the sources of variation in agriculture's financial structure. A model of time-varying parameters is used in econometric analysis. Farmer's investment responses in the 1970s appear to have been inconsistent with longer term trends. In particular, the cost of equity in the 1970s was driven down to unprecedented levels. The financial adjustments of the 1980s appear to have corrected for the inconsistencies of the 1970s and to have brought agriculture's financial structure more in line with long-term trends.

Key words: agricultural debt, farm finance, investment, time-varying parameters, marginal cost of equity.

Increased use of farm machinery relative to farm labor and higher farm real estate prices have been major contributors to mounting capital requirements in agriculture. Rising capital requirements have been met by increasing both internal equity and external debt capital. In the 1940s, the amount of equity capital in the agricultural sector almost tripled while the use of debt capital remained rather stable (USDA). From 1950 to 1970, however, the rate of growth in farm debt was twice the rate of growth in equity capital. In the 1970s, both debt and equity capital increased at about the same rate. During the 1980s farm debt has been reduced by one-fourth. Efficient use of debt capital will facilitate agricultural production and enhance the growth rate in the agricultural sector. On the other hand, inefficient use of debt capital in the farm financial structure may result in lower returns and/or higher financial risks. In particular, increased use of debt capital may increase financial risk and may place a heavy financial burden on farm operations. There has been increasing concern recently over the effect of high-interest-rate debt capital on rates of return and financial risk in agriculture. Hence, it is important to know how various factors influence farmers' decisions to use debt and equity capital to finance agricultural operations.

The overall purpose of this study is to analyze sources of variation in the equity-to-debt ratio in the agricultural sector through a value maximization framework. An adjustment process for the equity-to-debt ratio is incorporated into the model, and the parameters of the model are treated as time-varying parameters instead of constants. Use of the model developed in this study provides empirical estimates of the marginal cost of equity, which is an important criterion in farm investment

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decisions, and provides the debt elasticity of the marginal cost of equity. In the next section, the theoretical model is developed. Then the data and estimation method are discussed. Finally, results are presented and conclusions are drawn.

Theoretical Framework

In this study the value maximization rather than profit maximization behavior in the agricultural sector will be assumed. Profit maximization behavior has been the basis for much microeconomic analyses. The approach traditionally taken by production economists is to maximize profit subject to a technology constraint (production function) to determine the optimal quantities of inputs and outputs. One shortcoming of the profit maximization assumption is that it does not consider the business and financial risks involved in managing farm firms. The magnitude of these risks depends on the characteristics of the agricultural investment and on the level of debt employed in relation to equity in the farm capital structure. Returns to risks are viewed as part of the cost of capital in the capital asset pricing model (Hampton) and are an important component in the derivation of the required rate of return on capital. The value maximization approach takes risk into consideration (Van Horne) and is a more appropriate one to use in analyzing the financial structure for agriculture.

Following Vickers, the value of the ownership in the agricultural sector (V) is defined as

$$V_t = \pi_t / \rho_t, \tag{1}$$

where π is the profit function, ρ is the capitalization rate, or the rate at which farm income is capitalized, and t denotes time period. The capitalization rate, ρ, is a function of the amount of debt (D) employed. As the use of debt capital increases, there will be an increase in the risk of the equity owner's position. To compensate for the increased risk, the capitalization rate has to increase correspondingly. This concept is similar to the liquidity premium concept as discussed in Penson and Lins. The value of ownership and the capitalization rate can be viewed, respectively, as market value of equity and required rate of return on equity.

Consider the profit function in the agricultural sector with m outputs and n inputs subject to technology and money capital constraints:

$$\pi_t = \left[\sum_{i=1}^{n} P_{ti} Q_{ti} - \sum_{j=1}^{n} W_{tj} X_{tj} - r_t D_t\right] [1 - \tau_t] \tag{2}$$

subject to

$$Q_{ti} \leq f_t(X_{t1}, X_{t2}, \ldots, X_{tn})$$

$$\bar{E}_t + D_t \geq g_t(Q_{t1}, Q_{t2}, \ldots, Q_{tm}) + \sum_{j=1}^{n} \alpha_{tj} X_{tj},$$

where r is the average rate of interest on total debt; $\bar{E}$ is the amount of equity invested in the agricultural sector, which is assumed to be fixed for the moment; P is the price of output; Q is the quantity of output produced; W is the price of input; X is the quantity of input used; τ is the tax rate; f is the production function; g is a net working-capital requirement function that depends on the level of output; and α is the money capital requirement coefficient of each input. The profit function is somewhat different from the one usually seen in the sense that the capital constraint is imposed to recognize the need for capital in supporting the production function in the agricultural sector. Substitute (2) into (1) to obtain the value maximization model in the form of a Lagrangian function:

$$L_t = 1/\rho_t \left[\sum_{i=1}^{n} P_{ti} f_t(X_1, \ldots, X_n) - \sum_{j=1}^{n} W_{tj} X_{tj} - r_t D_t\right] [1 - \tau_t] + \mu_t \left[\bar{E}_t + D_t - g_t(Q_1, \ldots, Q_m) - \sum_{j=1}^{n} \alpha_{tj} X_{tj}\right], \tag{3}$$

where μ is the Lagrangian multiplier for capital. The value of μ represents the

marginal contribution of a dollar of capital to the value of the firm. If μ is greater than one, adding a dollar of capital will add more than a dollar to the value of the firm. As more capital is added the value of μ will fall. When μ has fallen to one, the value of the firm is maximized. The computation of μ is from a model that employs debt until its marginal value is equal to its marginal cost, given an amount of equity.

For the purpose of finding the optimal amount of debt capital, take the partial derivative of equation 3 with respect to debt and set it equal to zero:

$$\partial L_t/\partial D_t = -(\pi_t/\rho_t^2)(\partial\rho_t/\partial D_t) - r_t/\rho_t + \mu_t = 0. \quad (4)$$

When the use of debt is at the optimal level (D^*), denote the Lagrangian multiplier as μ^*. For the optimal level of debt, equation 4 can be rearranged as

$$\mu_t^* = (r_t/\rho_t) + (\pi_t/\rho_t^2)(\partial\rho_t/\partial D_t). \quad (5)$$

In the case in which μ^* is greater than one, additional capital needs to come from increases in equity capital. Therefore, $\bar{E}$ has to be increased to reach the desired position from the value maximization point of view. On the contrary, if μ^* is less than one, then too much equity capital is invested.

The optimal level of equity is found at the point where μ^* is equal to one. Only in the case that μ^* is equal to one (which Vickers refers to as maximum maximorum position) will $\bar{E}$ equal E^* (the optimal or desired level of equity capital) and D is also at the desired level, D^*. When μ^* is equal to one, equation 5 can be written as

$$\rho_t = r_t + (\pi_t/\rho_t)(\partial\rho_t/\partial D_t^*). \quad (6)$$

Recall that π/ρ is equal to the market value of equity capital. In the case that μ^* is equal to one, π/ρ is equal to E^*. Hence, equation 6 can be rewritten as

$$\rho_t = r_t + E_t^*(\partial\rho_t/\partial D_t^*). \quad (7)$$

The first term on the right-hand side of equation 7 is the direct cost of debt ($\partial r \cdot D/\partial D$), and the second term represents the necessary amount of change in earnings to compensate for the changes in risks, or the indirect marginal cost of debt. Therefore, the right-hand side of equation 7 can be referred to as the marginal cost of debt and, in equilibrium, should equal the marginal cost of equity. Hence, in equilibrium the marginal cost of equity is equal to the capitalization rate (ρ). Rewrite equation 7 in the following form:

$$ED_t^* = E_t^*/D_t^* = 1/\epsilon_t - (1/(\epsilon_t\rho_t))r_t, \quad (8)$$

where ϵ_t is $(D_t^*/\rho_t)/(\partial\rho_t/\partial D_t)$. ED^* is the ratio of the desired level of equity to the desired level of debt, and ϵ, which is called the debt elasticity of the marginal cost of equity, measures the percentage change in the marginal cost of equity resulting from a 1 percent change in the amount of debt.

Because ED^* is unknown, it is necessary to specify a relationship between ED^* and ED so that ED^* can be estimated. That relationship can be specified within the context of Nerlove's partial adjustment model, but in this study the adjustment coefficient is not restricted to be a constant. If only some variable portion of the desired adjustment is accomplished in each period, we have

$$ED_t - ED_{t-1} = C_t(ED_t^* - ED_{t-1}), \quad 0 \leq C_t \leq 1, \quad (9)$$

where C is the adjustment coefficient and varies from period to period. Financing farm firms is a lumpy process; refinancing farm real estate in particular will depend on both farmers' need for additional credit and their ability to obtain such credit. Hence, the adjustment coefficient is expected to change through time. Although this concept is new in analyzing farm financial structure, the assumption that C is variable is not unique (see, for example, Huffman). Substituting (8) into (9) to obtain

$$ED_t = (C_t/\epsilon_t) - (C_t/\epsilon_t\rho_t)r_t + (1 - C_t)ED_{t-1} = \alpha_t - \phi_t r_t + \delta_t \cdot ED_t, \quad (10)$$

where $\alpha = C/\epsilon \cdot \phi = C/\epsilon \cdot \rho$, and $\delta = 1 - C$ are the parameters to be estimated.

Equation 10 is the equation that will be estimated.[1]

Data

Data used in this study are annual times series data for U.S. agriculture over the period 1946–86. Variables included in the analysis are farm equity and debt (excluding farm households) and the total real cost of debt. The data for equity, debt, and interest rates are from *Agricultural Finance Databook* (Melichar). Farm taxes and income are from *Economic Indicators of the Farm Sector* (U.S. Department of Agriculture) and were used to calculate tax rates. The real cost of debt was adjusted for the tax rate, r = real cost of debt (1 − tax rate).

Estimation Method

The parameters in equation 10, α, ϕ, and δ are all functions of the time-varying parameter C and are treated as time-varying parameters. The varying parameter regression theory developed by Cooley and Prescott (1973, 1976) was applied to estimate the parameters of the model. Cooley and Prescott assumed that the parameters in their model are adaptive in nature, subject to permanent and transitory changes. The essence of their estimation method is to maximize a likelihood function by searching for the fraction of parameter variation that is due to permanent structural changes.

Consider the following model:

$$Y_t = X_t\beta_t, \qquad t = 1, 2, \ldots T, \tag{11}$$

where Y_t is the tth observation of the dependent variable, X_t is a K component vector of explanatory variables, and β_t is a K component vector of parameters subject to sequential variation.

Due to the variety of sources that originate parameter changes, it is assumed that some of the changes are permanent while others are transitory. Therefore, the parameters in equation 11 are assumed to be *adaptive* in nature and to have the following pattern of variation:

$$\begin{aligned} \beta_t &= \beta_t^P + U_t, \\ \beta_t^P &= \beta_{t-1}^P + V_t, \end{aligned} \tag{12}$$

where the superscript P denotes the permanent component of the parameters, U_t and V_t are identically and independently normally distributed with zero means and covariance structure of the form

$$\begin{aligned} \text{Cov}(U_t) &= (1 - \gamma)\sigma^2 \Sigma_U, \\ \text{Cov}(V_t) &= \gamma\sigma^2\Sigma_V, \quad 0 \leq \gamma \leq 1, \end{aligned} \tag{13}$$

where γ measures the fraction of parameter variation due to permanent structural changes. A large value of γ indicates that permanent changes are larger than the transitory changes. However, a value of γ close to zero indicates that changes are transitory. The matrices Σ_U and Σ_V are assumed to be known up to a scale factor (Judge et al.). In this study Σ_U and Σ_V are assumed to be equal and derived from the ordinary least squares (OLS) covariance matrix. The off-diagonal elements of Σ_U and Σ_V are the same as the off-diagonal elements of the OLS covariance matrix. The diagonal elements of Σ_U and Σ_V are the diagonal elements of the OLS covariance matrix normalized so that the element corresponding to the intercept is unity.

The concentrated likelihood function is

$$\begin{aligned} L_c(Y{:}\gamma) = &-T/2\,(\ln 2\pi + 1) - T/2 \ln S^2_{(\gamma)} \\ &- 1/2 \ln|\Omega_{(\gamma)}|, \end{aligned} \tag{14}$$

where $S^2_{(\gamma)} = 1/T\,[(Y - X\beta_{(\gamma)})'\Omega^{-1}_{(\gamma)}(Y - X\beta_{(\gamma)})]$. The value of γ between zero and one that maximizes the concentrated likelihood function is chosen as the parameter estimate for γ. This procedure produces a consistent estimator for γ that implies that the estimated coefficients are asymptotically efficient (Cooley and Prescott 1976). Empirically, Cooley and Prescott (1973) prove the robustness of the adaptive regression procedure to specification errors causing structural changes, relative to the OLS procedure.

Results

The time-varying parameter model was used to estimate equation 10 for U.S. agriculture

[1]While the theory was developed at the firm level, the variables used in the analysis are the same whether the average firm or the sector as a whole is used. Hence, no aggregation problems are expected.

for 1961–86. The procedure yields individual parameter estimates for each year. The parameter estimates are summarized for five-year intervals in Table 1. While the intercepts are not statistically significant, most other parameter estimates are highly significant. The overall fit of the model is good with an R^2 of .98.

The signs of the coefficients on real cost of debt in all years were negative, as expected (Table 1). There has been an upward trend in the absolute magnitude of the coefficient on the real cost of debt, indicating that farmers are becoming more responsive to changing interest rate levels. The signs of the coefficients on the lagged equity-to-debt ratio were positive in all years and less than one, indicating stability. This coefficient was near unity in the 1976–80 period, which indicates rigidity.

In the 1960s and 1980s the value of γ, the fraction of parameter variation due to permanent structural change, was relatively high, between .6 and .8 (Table 1). Those values indicate that from 60 to 80 percent of parameter variation was due to permanent structural changes in the 1960s and 1980s. In the 1970s the value of γ was much lower, indicating transitory changes predominated.

Actual and predicted equity-to-debt ratios for U.S. agriculture are reported in Table 2. The figures in this table are five-year averages. Predicted values are quite similar to actual values in all periods. The highest equity-to-debt ratio occurred at the beginning of the study period 1961–65. Those ratios trended downward over the study period with the exception of 1975–80, in which the ratio increased with favorable farm prices and rising land values. In the 1980s there has been a major reduction in the equity-to-debt ratio. That adjustment resulted from a cost-price squeeze and depressed land values.

The parameter estimates from Table 1 can be used to derive three additional parameters of economic significance, using equation 10. The parameters are the adjustment coefficient C, the debt elasticity of the marginal cost of equity ϵ, and the marginal cost of equity ρ. Table 2 reports those parameter estimates along with the actual and predicted ratios of desired equity to desired debt for five-year averages from 1961 to 1986.

The adjustment coefficients (C) reported in Table 2 range from .01 in 1976–80 to .17 in 1981–86. A low adjustment coefficient indicates that the financial structure in the agricultural sector has been rather rigid. Considering that real estate accounts for most of the debt and assets in agriculture, it is not surprising that the adjustment coefficient is at such a low level.

The adjustment coefficients were smaller in the 1970s than in the 1960s and 1980s (Table 2). Hence, the rate of adjustment of the actual equity-to-debt ratio towards its desired level was relatively low in the 1970s. However, the rate of adjustment has

Table 1. Regression Results Explaining Equity-to-Debt Ratio for U.S. Agriculture, Summarized by Five-Year Averages from 1961 through 1986[a]

	Intercept	Cost of Debt	Equity-to-Debt Ratio (Lagged)	γ[b]
1961–65	0.2571	−6.4602	0.9403	0.7560
	(0.4012)	(−0.8633)	(8.2651)	(5.1003)
1966–70	0.6447	−11.4304	0.8870	0.7840
	(1.0403)	(−2.2287)	(9.2762)	(3.3851)
1971–75	0.3365	−9.7055	0.9519	0.1120
	(0.9257)	(−3.3474)	(16.0914)	(2.9269)
1976–80	0.1312	−11.1314	0.9888	0.0000
	(0.7044)	(−5.1175)	(24.9412)	(0.0000)
1981–86	0.8112	−14.4849	0.8274	0.6033
	(1.6139)	(−2.2304)	(9.1705)	(3.2583)

[a]Estimated t-statistics are reported in parentheses.

[b]Fraction of parameter variation due to permanent structural changes.

Table 2. Equity-to-Debt Ratios and Derived Parameter Estimates for U.S. Agriculture, Summarized by Five-Year Averages from 1961 through 1986

	Equity-to-Debt Ratios		Adjustment Coefficient	Marginal Cost of Equity	Debt Elasticity of Marginal Cost of Equity
	Actual	Predicted	(C)	(ρ)	(ϵ)
1961–65	5.9095	5.8903	.0597	.0519	.1986
1966–70	4.8862	4.8814	.1130	.0583	.1599
1971–75	4.9196	4.9333	.0481	.0384	.1258
1976–80	5.0991	5.0885	.0112	.0118	.0853
1981–86	3.9459	3.9746	.1726	.0559	.2201

increased markedly in the 1980s. The average rate of adjustment in the 1980s has been .17, indicating that 17 percent of the desired adjustment has been completed within one year during the 1980s.

The marginal cost of equity capital represents the required rate of return in financing new farm investments from equity capital. The marginal cost of equity also serves as a threshold for acceptable internal rate of returns on using new investments. That is, a new investment must yield an expected rate of return at least as great as the marginal cost of equity in order to be undertaken. The marginal cost of equity also reflects the risks associated with production: a higher risk is associated with a higher marginal cost of equity, ceteris paribus. The estimated marginal cost of equity (ρ) has been higher in the 1960s and 1980s than in the 1970s (Table 2). Downside risks were lower in the 1970s, and farmers expanded investment in agriculture driving the marginal cost of equity to unprecedented low levels. Considerable financial and operational restructuring have been needed in the 1980s to yield marginal cost of equity estimates more consistent with historical rates.

An increase in debt capital will, ceteris paribus, reduce farm operators' credit capacity and increase their financial risks. Hence, the increased financial risk has to be compensated for in the form of a higher marginal cost of equity. The signs of the estimated demand elasticities of the marginal cost of equity are positive and consistent with expectations (Table 2). In the 1960s and early 1970s the elasticity ranged from .12 to .20. Hence, a 10 percent increase in debt caused the marginal cost of equity to increase 1.2–2 percent between 1961 and 1975. However, in 1976–80 the elasticity averaged only .085, indicating that higher debt levels had little impact on the cost of equity in the period. In the 1980s, the debt elasticity of the marginal cost of equity has rebounded, averaging .22.

Summary

The equity-to-debt ratio in U.S. agriculture averaged 5.9 in 1961–65. Then the ratio declined 17 percent and remained stable for one and one-half decades. In the 1980s it declined still further by 20 percent. This study has attempted to explain those abrupt changes in the equity-to-debt ratio. A value maximization framework was used as a basis to derive an empirical model for econometric estimation. All the parameters in the model were assumed to be time varying in nature and the techniques developed by Cooley and Prescott (1973, 1976) were applied to estimate the model. Transitory changes dominated the model only in the 1970s. During the 1970s the financial structure as measured by the equity-to-debt ratio remained stable, avoiding adjustments that otherwise would have been more consistent with long-term trends.

During the 1970s farmers made large investments in agriculture, driving the marginal cost of equity down to unprecedented levels. Those actions can be attributed to the favorable returns experienced by farmers and by an unwarranted perception of low risks. Farmers responded to the low returns and the high real interest rates in the 1980s by reducing debt and, hence, increasing the equity-to-debt ratio. The marginal cost of equity evident in the 1980s has been higher than in the 1970s and more in line with historical averages.

The optimal uses of debt and equity capital depend on the relative magnitudes of marginal cost of equity and the expected rate of return on new debt and equity capital. Thus, the estimated marginal cost of equity provides an important criterion in the capital budgeting process. In periods of unstable prices, costs, and interest rates, the role of the marginal cost of equity will become important in selecting the appropriate investment projects and in efficiently directing the flow of capital in the agricultural sector.

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Farm Liquidations in North Dakota: Consequences for Operators and Lenders

F. Larry Leistritz, Brenda L. Ekstrom, Arlen G. Leholm, and Janet Wanzek

Abstract

This article examines socioeconomic characteristics of North Dakota families who have left farming since 1980, analyzes the circumstances of their exit from farming, and describes their transition to new occupations and/or residential locations. The study is based on a survey of 169 former farm operators. Results indicate that most started farming during the 1970s. About 28 percent of the total loan dollars owed was left unpaid when they quit farming, and 42 percent of the former operators incurred contingent tax liabilities averaging $20,000. At the time of the survey their assets averaged $164,000, and debts averaged $166,000.

Key words: displaced farmers, financial characteristics, agricultural lenders, North Dakota.

A number of recent articles and reports document the financial pressures that the economic conditions of the 1980s have imposed on many farm and ranch operators (Johnson et al.; Harrington and Carlin; Lines and Morehart). Several analysts examined the alternatives available to operators with weak solvency positions and/or inadequate cash flow (Brake and Boehlje; Doye et al.). Although debt restructuring, asset restructuring, enterprise reorganization, or some combination of those measures may enable many operators to remain in agriculture, most of the analysts concluded that a substantial number of producers will be forced out of farming and some agricultural lenders will be vulnerable to substantial losses (Harl; Melichar).

Little information is available, however, concerning the characteristics of producers who are being displaced from agriculture and the consequences of the farm liquidation process for both farm families and their lenders. Although several analyses have attempted to project the characteristics of farmers who may leave farming, based on balance sheet and cash flow characteristics of present farm operations (see for example, Runge; Leholm et al.), only a few studies focused on families who have already ceased farming due to financial pressure. Furthermore, the studies that dealt directly with displaced farm families have been limited by relatively small sample sizes (Heffernan and Heffernan; Graham) or by reliance on secondary information (Otto; Henderson and Frank).

This article examines the socioeconomic characteristics of North Dakota families who have left farming since 1980, analyzes the circumstances of their exit from agriculture,

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and describes their transition to new occupations and/or residential locations. The article begins with a brief description of study procedures, then examines specific characteristics of displaced farm families before drawing conclusions and discussing future implications. To place the characteristics of the displaced farm families in perspective, their attributes are compared with those of a cross section of households that were operating farms in 1986 (Leistritz et al. 1987b), and their financial characteristics are compared with rural community residents (Leistritz et al. 1987a).

Study Procedures

Information concerning characteristics of displaced farm families was obtained from a September 1986 telephone survey. It incorporated a series of screening questions to determine if the respondents (*a*) no longer operated a farm, (*b*) did not plan to plant a crop in 1987, (*c*) had ceased to farm in 1981 or later, (*d*) were less than 65 years old when ceasing to farm, (*e*) sold more than $2,500 of farm products in the year prior to terminating the farm operation, and (*f*) considered farming to be their primary occupation prior to quitting.

A list of 432 farm operators who had ceased operation since 1980 for reasons other than retirement was compiled. (The names were obtained from government agencies that have frequent contact with farmers.) Of those, 260 were contacted by phone, and the remainder received questionnaires in the mail. Altogether, 169 usable questionnaires were completed; 87 percent were from respondents still living in North Dakota, and 13 percent were from operators who had relocated out of state. (Copies of the questionnaire are available on request from the authors.)

Findings

Key information obtained from the survey respondents is summarized in this section. The summary is organized into subsections that describe the following: farm and farm financial characteristics, liquidation procedures, demographic characteristics, circumstances of transition, current employment, and family well-being.

Farm Characteristics

Of the respondents, 79 percent had ceased farming in 1983, 1984, or 1985, and more than half had begun farming during the 1970s. The characteristics of their farms were quite similar to those found in a statewide survey of farmers who were currently operating and who considered farming to be their primary occupation. For example, the average number of acres operated by the displaced farmers was only about 7 percent less than that operated by current farmers (Table 1). Crop farms predominated in both groups as did the sole proprietorship form of business organization.

The displaced farm operators were asked several questions about their income during the last complete year they had operated the farm. The average gross cash farm income of the former farmers was $101,045, only 9 percent less than the average gross income reported by current farmers for 1985 (Table 2). Both groups were dominated by commercial-size family farms with total sales in the range of $40,000 to $250,000.

Net cash farm incomes of the two groups, however, were dramatically different. The average net cash farm income of former farmers was −$12,420 (Table 2), but the average net cash farm income for operating farmers was $15,958 in 1985 (Ekstrom et al.). More than 60 percent of all the former farmers had a negative net cash farm income in their last year of farming. Additionally, 61 percent of all former farmers indicated that their last production year was a typical one. The average net cash farm income of those who said it was a typical year was −$6,960 (the median amount was −$5,000), and 59 percent of them reported negative net cash income. A major factor causing the former farmers to have low or negative net incomes was their high debt loads.

Liquidation Procedures

The former farmers were asked how they had disposed of their assets. Only 14 percent of 142 former farmers who owned land sold all their land, 44 percent deeded their land back to a private individual or a financial institution, and another 27 percent

Table 1. Selected Farm Characteristics of North Dakota Former and Current Farm Operators

Item	Former Farmers	Current Farmers[a]
Year started farming		
Before 1965	32.0%	50.6%
1965–1969	11.2	9.8
1970–1974	22.5	14.8
1975–1979	29.0	15.7
1980–1984	5.3	8.9
Year quit farming		
1981	3.0%	—
1982	7.7	—
1983	17.2	—
1984	26.0	—
1985	35.5	—
1986	10.7	—
Total acres operated		
Mean	1,466.0	1,556.9
Median	1,220.0	1,200.0
Farm type[b]		
Crop	57.4%	68.3%
Beef	15.4	13.5
Dairy	10.7	5.5
Diversified	16.6	12.7
Type of business organization		
Sole proprietorship	87.0%	80.3%
Partnership	8.9	16.6
Family-held corporation	4.1	2.7
Other	0.0	0.4

[a]Source: Leistritz et al. 1987b.

[b]Farms were classified by type if more than 50 percent of gross farm income came from a particular source; farms were classified as diversified if no one source accounted for more than 50 percent of gross farm income.

retained ownership of all their land (Figure 1). Several respondents reported that a combination of disposal methods were used. More than 75 percent of the former farmers sold their machinery and breeding livestock (if any) either publicly or privately; just over 5 percent conveyed those assets back to a creditor, and about 6 percent retained them.

Overall, the former farmers had an average total debt of about $263,000 at the time they liquidated. Approximately 38 percent of those individuals were able to satisfy all of their obligations to their creditors. The remaining producers were not able to fully meet all their obligations. On average, those persons left about $123,300 in unpaid claims when they ceased farming (the median amount was $65,000). Nevertheless, only 11 percent of the respondents had filed for protection under bankruptcy laws. Of the total debt owed by the former farmers surveyed, about 30 percent was reported to have been unpaid (Table 3).

Some creditors of this group of liquidating farmers suffered substantial losses. The operators surveyed reported a total of 425 loans, of which 31 percent were operating loans, 24 percent were intermediate-term loans, and the remainder were long-term loans secured by real estate. Overall, 39 percent of all loans and unsecured debts were not paid in full when the farming operation was liquidated. The percentages varied substantially among lenders, ranging from 46 percent unpaid to FmHA to 35 percent for the Federal Land Bank, 29 percent for commercial banks, and 24 percent for the Production Credit Association (PCA). Unsecured creditors had a much worse experience, however; three-fourths of those obligations (such as

Table 2. Selected Farm Financial Characteristics of North Dakota Former and Current Farm Operators

Item	Former Farmers	Current Farmers[a]
Gross cash farm income (during last complete year of farming)[b]		
Average	$101,045	$110,266
Distribution:		
Less than $19,999	5.0%	5.1%
$20,000–$39,999	14.9	16.1
$40,000–$99,999	44.1	41.2
$100,000–$249,999	26.1	30.4
$250,000 and over	9.9	7.4
Net cash farm income (during last complete year of farming)		
Average	−$12,423	$15,958
Distribution:		
Less than −$10,000	44.7%	8.6%
−$9,999–$0	17.1	15.2
$1–$9,999	17.1	23.8
$10,000 and over	21.1	52.4

[a]Source: Leistritz et al. 1987b.

[b]Gross cash farm income includes government payments and custom work performed for others but excludes any hunting and oil or gas lease income.

accounts with input suppliers and rent due to landlords) were not paid in full.

Contingent tax liabilities are also a major concern in farm liquidations. (For a detailed discussion of contingent tax liabilities, see Saxowsky et al.) Selling assets in a liquidation can trigger the following contingent tax liabilities:

- Recapture of investment credits
- Recapture of depreciation
- Capital gains taxes
- Ordinary income tax arising from debt forgiveness
- Other taxes

Many of the former farmers (15 percent) were unsure of their contingent tax liabilities because the process of liquidation can take quite some time and because tax consequences were still being determined (Table 4). Nevertheless, 42 percent stated they had tax consequences involving their liquidation.

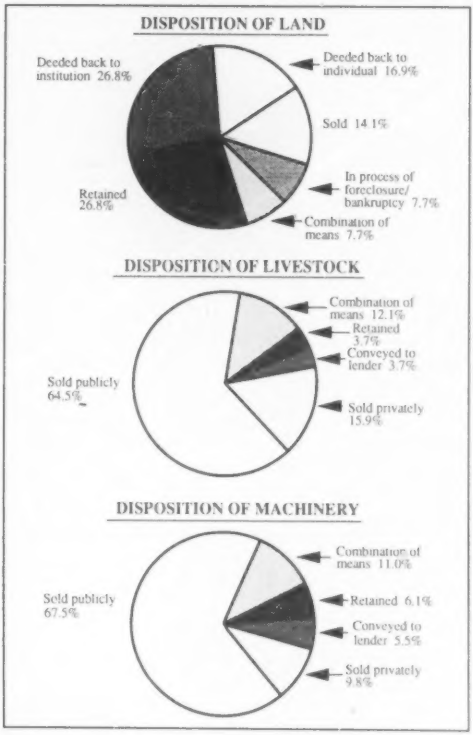
Sixty-two of the former farmers (or 42 percent of the respondents) had an average additional tax liability of $20,117. Twenty-seven percent had added tax liabilities under $5,000, but nearly 10 percent had liabilities over $40,000. Table 4 also illustrates the factors they believed contributed to additional liabilities. About half of these farmers stated that recapture of investment tax credit, additional capital gains tax, and recapture of depreciation contributed to their tax liabilities.

Demographic Characteristics

Selected demographic characteristics of the former farm operators surveyed are summarized in Table 5. The average age of the respondents was 41 years, and 65 percent were younger than 45. Of the respondents, 96 percent were male and 90 percent were married. Average household size was 3.9 persons. About 51 percent of the respondents and 53 percent of their spouses had received some postsecondary education. Fifty-six percent of the respondents were still living in the county where their farm had been located, 32 percent had relocated to another county in the state, and 13 percent had moved out of state.

Respondents under age 45 and those with college degrees were much more likely to have moved from their home county, although there were no marked differences in relocation in the other educational levels. Relocation status did not seem to be

Figure 1. Method of Asset Liquidation for Land, Livestock, and Machinery for Former North Dakota Farmers



consistently related to the year that the operator ceased farming. However, there was a slight tendency for respondents with higher levels of net worth to remain in the community, while those with lower levels of equity chose to relocate.

Transition

Survey respondents also were queried concerning the agencies or organizations they had contacted and the assistance programs they had utilized during their transition out of farming. The North Dakota Job Service was the agency contacted most frequently, followed by the County Social Services, churches, the Cooperative Extension Service, and the State Credit Review Board (Figure 2). These percentages are substantially greater than those reported by other researchers (Heffernan and Heffernan) and suggest that some of the new and expanded programs offered by various agencies are reaching a substantial number of farm families. Nevertheless, 31 percent of the respondents had not contacted any of the agencies listed.

Specific governmental assistance programs and services used by the respondents are illustrated in Figure 3. Fuel assistance was the program most frequently utilized, followed by educational grants, food stamps, and credit counseling. It is interesting to note that 43 percent of the respondents had not used any of the programs listed.

Employment Characteristics

Finding suitable employment has been identified as one of the most frequently encountered problems associated with the transition out of farming (Graham; Hill; Guither). The survey respondents were asked how many months it had taken to find employment. Forty-six percent of the respondents reported a search of two months or less, and slightly more than 60 percent searched for less than three months. Approximately 41 percent indicated that they had to move to find employment, but 58 percent of those would have preferred to have stayed in or near their home town.

The experience of the displaced farm operators in seeking alternative employment can be compared with that of displaced workers nationwide. A 1984 survey of more than five million workers who had lost their jobs after a tenure of three or more years revealed that, of the 60 percent who had found new employment at the time of the survey, the median period without work had been six months, and 14 percent had relocated to find work (Flaim and Sehgal). In contrast, 83 percent of the displaced farmers had found employment, the median period without work had been slightly over two months, but 41 percent of those had to move to find a job.

In addition to the 83 percent of the respondents who were employed at the time of the survey, 8 percent were unemployed, 6 percent were full-time students, and 3 percent were retired. The percentage of former farmers who were currently employed was highest (95 percent) for

Table 3. Summary of Unpaid Liabilities by Type of Lender

Lender	Percent of Obligations Not Fully Satisfied to Source	Percent of Obligation Dollars Not Paid to Source	Percent of Total Loan Volume (Dollars)	Percent of Total Loan Dollars Not Paid
Banks	28.6	16.9	15.4	8.8
PCA	23.5	14.0	4.2	2.0
FmHA	45.7	37.4	40.9	51.5
Private individuals	20.0	29.9	0.4	0.4
Machinery companies	30.0	9.3	0.7	0.2
Federal Land Bank	34.7	32.4	19.1	20.8
Contract for deed	12.5	23.2	5.3	4.1
Other	2.4	4.3	9.7	1.4
Unsecured creditors	76.7	73.9	4.3	10.8
Total	38.8	29.7	100.0	100.0

those who were under age 45 and had no education beyond high school. For those over age 45 with no education beyond high school, however, the unemployment rate was nearly 23 percent. Overall, 57 percent of their spouses were currently employed, but the percentages varied considerably by educational level. Of those who were under age 45 and had completed college, 83 percent were employed. On the other hand, one half of the spouses with no education beyond high school were not employed. Occupations most frequently reported by respondents were farm work (17.8 percent), sales (15.5 percent), transportation (14 percent), and construction crafts (12.4 percent), while their spouses were most often employed in administrative support (36 percent), professional specialties (19.8 percent), services (16.3 percent), or sales (10.5 percent).

About 71 percent of the employed respondents indicated that they were satisfied with their present employment. However, 39 percent of all respondents indicated that they were likely to look for different employment in 1986, and about 31 percent of all spouses were described as likely to look for different employment. The respondents would most often seek employment as truck drivers or farm

Table 4. Contingent Tax Liabilities of Former North Dakota Farmers

Item	Number	Value
Did ceasing to farm result in additional income tax liabilities?	161	
No		42.9%
Yes		42.2
Don't know		14.9
Total additional tax liability	62	
Average		$20,117
Distribution:		
$0–$4,999		27.4%
$5,000–$9,999		12.9
$10,000–$14,999		16.1
$15,000–$19,999		11.3
$20,000–$29,999		9.6
$30,000–$39,999		12.9
Over $40,000		9.7
Factors contributing to additional tax liabilities	92	
Recapture of investment credits		52.2%
Recapture of depreciation		48.9
Additional capital gains taxes		52.2
Debt forgiveness		25.0
Other		6.5

Table 5. Selected Demographic Characteristics of North Dakota Former Farm Operators

Item	Former Farmers	Current Farmers[a]
Respondent age		
Average age	41.1	45.1
Distribution		
Less than 35 years	29.3%	23.5%
35 to 44 years	35.3	23.4
45 to 54 years	22.2	25.6
55 to 64 years	13.2	27.6
Respondent sex		
Male	95.8%	98.7%
Female	4.2	1.3
Marital status		
Single	3.6%	12.2%
Married	89.8	85.7
Separated or divorced	6.6	1.3
Widowed	0.0	0.8
Household size (average)	3.9	3.4
Highest level of education completed by respondent		
Eight grade or less	7.8%	16.1%
Some high school	3.0	9.1
Completed high school	38.3	36.1
Attended college or postsecondary school	36.5	26.5
Completed college	14.4	12.2
Present residence of respondent		
Same county	55.7%	—
Relocated within state	31.7	—
Out of state	12.5	—

[a]Values for current farmers are for 1986 (Source: Leistritz et al. 1987b).

workers, and spouses were most likely to seek jobs as bookkeepers, registered nurses, and secretaries.

Among the households where one or both marriage partners were likely to look for a different job, about 70 percent indicated that they were willing to move to another community to find employment. The fact that about 27 percent of all survey respondents fell into that category suggests

Figure 2. Agencies Contacted During Transition Out of Farming

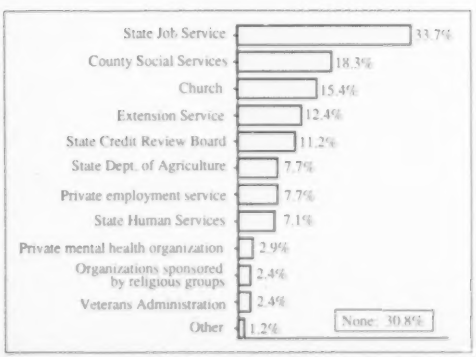
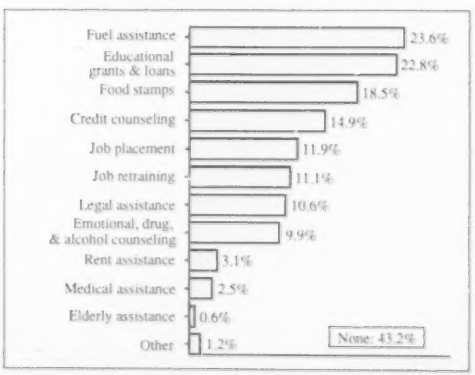


Figure 3. Programs and Services Utilized During Transition Out of Farming



that the transition process may not yet be complete for many displaced farm families.

Family Well-Being

The respondents also were asked about their family income for 1985 and the value of their assets and level of debt as of December 31, 1985. The respondents reported that their total family income (adjusted gross income) for 1985 averaged $29,411 (Table 6). A few very large values greatly influenced the average. The median, or midpoint, was $18,000 and may more accurately reflect the typical respondent's gross income.

To further put the current status of former farmers into perspective, we compared their financial status with that of a group of rural residents in six selected North Dakota communities (Leistritz et al. 1987a). The average family income of the former farmers was higher than that of the residents, but the median fell $5,000 below the residents' median income. About 13 percent of the former farmers reported a negative income level, and another 16 percent had incomes of less than $10,000 (only 14 percent of the residents had a total income of less than $10,000). Wages and salaries were the largest component of total income, averaging about 56 percent, followed by farm profit or loss and income from farm land rental.

Overall, almost 29 percent of the former farmers had incomes below the poverty level in 1985. The percentages of households in poverty was higher than average for households in which the respondent was younger than 45 and had no education past high school, for those who remained in their home county, and for

Table 6. Family Income and Financial Resources of North Dakota Former and Current Farm Operators, December 31, 1985

Item	Former Farmers	Current Farmers	Community Residents
Total family income			
Mean	$29,411	$24,683	$25,741
Median	18,000	15,400	23,000
Total assets			
Mean	164,221	413,396	78,540
Median	65,000	300,000	60,000
Total debts			
Mean	165,825	141,409	21,037
Median	60,000	76,000	7,500
Net worth[a]			
Mean	−3,148	267,445	55,550
Median	11,000	164,000	34,000
TFI − FLE[b]			
< −$5,000	19.7%	23.7%	1.8%
−$4,999 to 0	8.8	12.9	7.8
$0 to $4,999	13.6	13.0	11.1
$5,000 to $19,999	29.9	23.5	49.2
$20,000 and over	27.9	27.0	30.2
Debt-to-asset ratio			
No debt	10.0%	18.2%	26.0%
.01–.40	22.0	41.4	41.8
.41–.70	24.7	23.5	18.3
.71–1.00	13.3	11.7	8.7
>1.00	30.0	5.2	5.2

[a]Average net worth does not equal average assets minus average debt because not all respondents answered questions about both their assets and debts.

[b]TFI − FLE = Total Family Income minus Family Living Expenses. Total family income is the sum of net cash farm income and nonfarm income. A minimum family living expense allowance was estimated to be equal to the poverty income thresholds as defined by the Bureau of Labor Statistics.

those who had quit farming in 1985 or 1986. At the other extreme, about 18 percent had incomes greater than $40,000. In contrast, only 10 percent of the community residents fell below the poverty line, but 37 percent of the current farmers fell below when depreciation was included as an expense.

The greatest differences are found when comparing the assets, debts, and net worth of the former farmers with that of current farmers and community residents. The former farmers indicated that the value of their assets as of December 31, 1985, averaged about $164,000 and their total debt averaged nearly $166,000. Again, the medians, or midpoints, fell substantially lower. The median value was $65,000 for assets and $60,000 for debts. Only 10 percent of the former farmers had no debt, compared with 18 percent of the current farmers and 26 percent of community residents. The median debt-to-asset ratio for former farmers was .65; however, 30 percent of the respondents had a debt-to-asset ratio over 1, which means their debts exceeded their assets. That is in stark contrast to the 5 percent of current farmers and community residents who had a debt-to-asset ratio over 1.

The net worth of former farmers also highlights their economic struggles. Their average net worth was −$3,148, and the median was somewhat higher at $11,000. Community residents, in contrast, had an average net worth of $55,550, and current farmers had an average net worth of $267,445. About one-third of the former farmers indicated a negative net worth, while another 17 percent reported a positive net worth of less than $10,000. At the other extreme, about 17 percent had a net worth of more than $100,000.

Respondents were also asked whether they felt they were better off financially since they quit farming. About 63 percent felt they were better off. Reasons frequently given by those who believed they were better off were that they had less or no debt (43.6 percent) and more income (39.4 percent).

Comparison with Previous Findings

Results of the North Dakota analysis are similar in most respects to those of recent studies conducted in Iowa (Otto) and Ohio (Henderson and Frank). Both of those studies also found that most of the displaced farmers had been operating commercial-size family farms and that they were generally younger than the average current producer. Assets were typically liquidated through voluntary sale or conveyance to creditors rather than through foreclosure or bankruptcy. For example, only 13.7 percent of Ohio farmers studied had filed for bankruptcy. Most of the displaced producers had also succeeded in finding alternative employment; only 9.3 percent of the Ohio farmers and 14.9 percent of those in Iowa were unemployed at the time the studies were conducted.

One aspect in which the results of the Iowa and Ohio studies differed from those of the North Dakota survey was the relocation of displaced farmers. The percentage of displaced North Dakota farmers who had relocated from their home counties (45 percent) was substantially higher than corresponding values in Ohio (27 percent) and Iowa (23 percent). One likely explanation for the difference would be the sparse population and small number of nonfarm job opportunities in many of North Dakota's more agriculturally dependent counties.

Conclusions and Implications

The purpose of this study was to examine the socioeconomic characteristics of North Dakota families who had left farming since 1980, to analyze the circumstances of their exit from agriculture, and to describe their transition to new occupations and/or residences. Some key conclusions of the analysis include the following:

- Most displaced farmers had started farming during the 1970s, and their farms were similar in size and type of enterprises to those of current farm operators. Most displaced farm operators, however, were younger than the average of the farm population and had higher levels of education and larger households.
- Voluntary sale or conveyance to creditors was the most common means

of asset liquidation. Bankruptcy was utilized by only a small minority of respondents.

- Overall, 32 percent of all loans were not paid in full when the farming operation was liquidated. The unpaid liabilities represent substantial losses for some creditors. About 28 percent of the total value of the displaced farmers' total operating, intermediate-, and long-term loans were uncollectable when the business was liquidated. Unsecured creditors suffered even heavier percentage losses—they were unable to collect 74 percent of the dollar amount out on credit.
- Contingent tax liabilities were a substantial problem for many attempting to liquidate their farm operation. About 42 percent of respondents reported that liquidation had resulted in increased liabilities; the average liability incurred was about $20,000.
- Although many agencies have launched programs to assist farmers in the transition to new occupations and residences, there is reason to believe that many farm families have not been reached. This points out the need for additional efforts to increase awareness of the programs.
- The displaced farmers were relatively successful in obtaining alternative employment. About 83 percent were employed at the time of the survey, and about 61 percent reported a job search of less than three months. However, about 41 percent reported that they had to move to another area to find work.
- For many survey respondents, the transition may not yet be completed. Of the respondents, 39 percent indicated they were likely to look for different employment in the next year and about 70 percent of those indicated that they were willing to relocate. Many are also carrying with them a legacy from their farming career—debt to creditors or to the federal government.
- The financial resources of most displaced farm families are quite limited. The median family income for the group was $18,000, and 29 percent reported incomes of less than $10,000. About one-third reported that their debt currently exceeds the value of their assets, and another 17 percent reported a positive net worth of $10,000 or less. Nevertheless, about 63 percent felt that they were better off financially since they quit farming.

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Financial Soundness of Southern Dairy Farmers Participating in the Dairy Termination Program

Dale H. Carley and Stanley M. Fletcher

Abstract

A high percentage of southern dairy farmers exited dairy farming through the Dairy Termination Program (DTP). In the analysis each farmer was placed in a discrete financial category based on more than one measure of financial soundness. A multiresponse ordered model was used to examine the factors that determined the financial soundness of the dairy farmer participants. Results indicated that older dairy farmers, with smaller herds, and with relatively high production efficiency were in the best financial condition. Younger farmers, farmers with larger herds, or with lower producing cows were in a poor financial condition. A policy that pays farmers to exit will include farmers with a wide range of financial conditions.

Key words: dairy farmers, financial, farm policy, farm business exit.

The DTP was a major component of the Dairy Title in the 1985 farm legislation passed by Congress. It was a voluntary program in which dairy farmers in any state could sell their milk production rights to the Secretary of Agriculture. Dairy farmers determined their milk marketing base, based on the volume of milk marketed in 1985, and submitted dollar per hundredweight bids to the Secretary. If the bid was accepted, the dairy farmer agreed to cease milk production for five years. The farmer was required to sell all his female dairy animals either for slaughter or for export within a specified time period. Each dairy farmer having an accepted bid receives, over a period of up to five years, a payment equal to the base marketings times the bid price.

Nationally, bids were accepted up to and including $22.50 per hundredweight of milk. Because bid prices were accepted without regard to regional differences in the proportion of milk marketings to be removed from the market, there was a much higher proportion of the total marketings removed in some states than in others. In terms of the impact of the DTP on milk marketings, three southern states (Alabama, Georgia, and Mississippi) were ranked in the top eight states in the nation in the proportion of 1985 milk marketings to be removed from the market.

The proportion of dairy farmers who had bids accepted in those states, as a percentage of the total farmers in the states, closely paralleled the proportion of milk marketings. Therefore, an estimated 21 percent of the total dairy farmers in the three states had bids accepted. There was evidence indicating that a high percentage of dairy farmers in the South would

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participate in the DTP. In the Appalachian region of the United States, residual returns to management and risk for dairy farmers during 1975–86 averaged the second lowest of the six dairy production regions (Betts; U.S. Department of Agriculture). Only the Corn Belt dairy farmers averaged lower. A study of financial indicators of specialized dairy farmers showed that 27 percent of the southern dairy farms had a negative revenue in 1985, the third worst of the eight U.S. regions (Ahearn et al.). However, the southern dairy farmers had the best debt-to-asset ratio (14 percent). Low returns in dairy farming may partially explain the reasons for the relatively high participation in the DTP.

A study evaluating the reasons for participation in the DTP of those farmers whose bids were accepted in four southern states indicated that some had financial problems (Carley et al.). Nearly one-fourth of the dairy farmers had a negative net income in 1985 and about 40 percent indicated debt problems. However, more than one-half of the dairy farmers indicated they had a positive net income in 1985, and they had no serious debt problems.

Substantial variability in the financial conditions of the dairy farmers accepted for participation in the DTP was evident. Given that finding, the objective of this study was to determine factors explaining the variability in financial conditions of the dairy farmers accepted in the DTP. The DTP was a unique supply management program in that it took whole farm units out of production through an income payment provision. An understanding of the factors associated with the financial health of dairy farm units that choose to cease operations under such a program may assist policy makers in knowing the kind of farm operations financially that may respond as participants in similar programs.

Economic Model

Dairy farmers did not know at the time they offered their bids the maximum bid price that would be accepted. Farmers whose bids were accepted under the voluntary program were operating under a wide range of financial conditions. With such policy programs, the inefficient farmer or those with financial problems may not be the only ones to participate. An analysis of participants in the 1984–85 milk diversion program showed that many factors explained participation in that program (Lee and Boisvert). Results of a study of bid decisions for the DTP showed that several income factors, production changes, and experience with past farm programs influenced sign up rates and bid levels (Kaiser and Lee). Chambers and Foster in a study of participation in the Farmer-Owned Reserve showed that farmer response was different between corn and wheat farmers. These studies point out that a given policy may have varying effects on the level and type of farmer participant.

For a subclass of dairy farmers whose bids were accepted for DTP participation, a model was designed to determine the factors affecting the financial soundness of their operations. Measures of financial soundness of a farm business have been identified as liquidity, solvency, and profitability (Lines and Morehart; Penson and Lins). For this analysis a two-dimensional variable was defined to assess the financial soundness of the dairy farmer participants. The variable incorporated the net income of the dairy farmer in 1985 and the ability of the farmer to pay off his debts with the income received from DTP participation. The latter measure was determined by asking the farmer to estimate the percentage of funds that would be retained, after paying all debts, from the funds received from the DTP contract, sales of all the dairy animals, and sales of other items used in the dairy operation.

Net income is a prime determinant of financial soundness of a dairy farm business. A high annual net income indicates a favorable profit in which to service debt in that year. A reasonably high asset-to-debt relationship indicates that profits have been satisfactory over time to service debt and to increase the net worth of the farm. However, at any point in time there may be a high net income level but a low asset-to-debt relationship, or a low or minus net income but a high asset-to-debt relationship, or both a low or minus net income and a low asset-to-debt ratio. Therefore, by combining the two measures

into a measure of financial soundness, it was possible to capture various levels of financial conditions at a point in time.

The following factors were hypothesized to explain the financial soundness of the dairy farmer participant. Larger dairy farm operations, as determined by the number of dairy cows, were expected to be less financially sound than smaller operations. An analysis of 3,400 southern dairy farms showed that the farms with smaller herds had a better financial status than farms with larger herds (Carley). The pounds of milk marketed in 1985 was expected to have a positive effect on financial soundness. Embodied in pounds of milk marketed was the average production per cow. Thus, two farmers with a similar number of dairy cows, but with different levels of production per cow, would be expected to be at different levels of financial soundness. The farmer with the higher production per cow would be more financially sound. Recent studies of the relationship of the cost of milk production and milk production per cow show that costs per unit decrease with increasing production per cow (Brown and Ely; Grisley and Jenkins; Mix and Kelner).

Specialization in dairy farming was hypothesized to have a positive influence on financial soundness. Dairy farmers who received most of their farm income from the dairy operation were expected to be better managers resulting in a higher net income and lower debts than those with more diversified farming operations.

The age of the operator, which was assumed to be a proxy for dairy farming experience, was expected to have a positive effect on financial soundness. If a farmer has been a good manager, then the additional years in the dairy business should result in lower relative debts and a better net income.

Data Base

The source of data used in this study was from the survey of dairy farmers in Alabama, Georgia, Louisiana, and Mississippi whose bids were accepted for participation in the DTP. Dairy farmers in the four states had similar milk production and marketing characteristics (Carley). A questionnaire was sent to each of the 533 dairy farmers who had bids accepted. Usable questionnaires for this study of financial soundness were obtained from 166 dairy farmers. Data in Tables 1 and 2 show population and sample observations and means. About the same percentage of dairy farmers from each state were included in the sample as were in the total population of DTP participants. The test of differences between the means of the total population and the sample for selected variables indicated that there was no statistical difference. This implies that the sample was representative of the population.

Each dairy farmer was placed in one of three financial soundness categories based on net income in 1985 and asset-to-debt relationships (Table 3). The simple correlation between net income and the asset-to-debt ratio was .48 indicating that using both measures was better than using either one. The farmers in the most financially sound class had a positive net income in 1985 and would, after paying all debts, retain 50 percent or more of the total funds received as a result of participating in the DTP. The second class had a positive net income, but after paying debts, they would retain none to 49 percent of the funds received. The third class had a negative net income in 1985 and would

Table 1. Distribution of Total and Sample Number of Dairy Farmers with Bids Accepted for the Dairy Termination Program, Four Southern States, 1986

	Total Population		Sample	
State	Number	Percent	Number	Percent
Alabama	91	17	30	18.1
Georgia	179	34	53	31.9
Louisiana	90	17	30	18.1
Mississippi	173	32	53	31.9
Total	533	100	166	100.0

Table 2. Population and Sample Means for Selected Variables of Dairy Farmers with Bids Accepted for Dairy Termination Program, Four Southern States, 1986

Variable	Population Mean	Sample Mean	*t*-value[a]
Cows (100)	1.096	1.207	1.083
Base marketings			
Per farm (mil lbs)	1.195	1.312	1.047
Per cow (thous lbs)	10.900	10.870	−0.758

[a]Value resulting from a test for difference between population and sample means. The critical *t*-value for 165 degrees of freedom at a significance level of .05 was 1.96.

retain from none to 74 percent of the funds received.

The financial soundness distribution of dairy farmers by state based on the above definition is shown in Table 4. Mississippi had the highest percentage of dairy farmers in the best financial category, while Louisiana had the highest percentage in the worst financial category.

The variables hypothesized to influence the financial soundness of a dairy farmer participant were the number of dairy cows (in 100s) in the herd (*COWS*), the pounds of base marketings (in millions) of the dairy farm (*BMKT*), the proportion of total farm income received from the dairy farm operation (*PNCT*), and the age of the dairy farm operator (*AGE*). Differences were expected among the four states in the possibility of a farmer being in a specific financial category, therefore the states were entered as intercept shifters with Georgia as the base.

Econometric Specification

Given that the dependent variable—the financial soundness category of each dairy farmer—was a discrete qualitative variable, the use of ordinary least squares would result in biased and inefficient estimates (Judge et al.) Furthermore, because the dependent variable was defined as those dairy farmers who fall within a specified financial class, a multiresponse ordered model, as discussed in Amemiya and in Maddala, was used for estimation instead of the traditional qualitative choice models (i.e., logit and probit). That model was the appropriate one to use when the dependent variable has more than two outcomes and the outcomes can be ranked. The model was utilized by Carley and Fletcher in explaining factors affecting decisions by dairy farmers to use a given combination of management practices. The rest of this section provides a description of the econometric model.

The continuous financial soundness of the tth farmer is denoted y_t and is assumed to be linearly related to a vector of observed farmer characteristics. It can be represented mathematically as

$$Y_t = X_t\beta + e_t \qquad (t = 1,2, \ldots, n)$$

where X_t is a vector of farmer-specific variables, β denotes the parameters to be estimated, and e_t is the error term and is assumed to be normally distributed. Because Y_t is not observable, a vector of

Table 3. Financial Soundness Classification for Dairy Farmers Participating in the Dairy Termination Program, Four Southern States, 1986

Financial Soundness Category	Measures of Financial Soundness	
	Net Income in 1985	Proportion of Funds Retained[a]
0 (best)	Positive	.5 to 1.00
1	Positive	.0 to 0.49
2 (worst)	Negative	.0 to 0.74[b]

[a]Proportion of funds retained, after paying debts, of those received from the DTP contract, sale of dairy animals, and sale of other items used in the dairy operation.

[b]No dairy farmer in this category was above .74.

Table 4. Financial Soundness of Dairy Farmers Participating in the Dairy Termination Program, Four Southern States, 1986

Financial Soundness Category[a]	Alabama	Georgia	Louisiana	Mississippi	All Farmers
			Percent of Farmers		
0 (best)	50.0	41.5	23.3	62.3	46.4
1	33.3	30.2	36.7	22.6	29.5
2 (worst)	16.7	28.3	40.0	15.1	24.1
Total number	30.0	53.0	30.0	53.0	166.0

[a]See Table 3 for definitions.

binary variables indicating which range of financial soundness the tth farmer is classified is denoted $D_t = [d_{1t}, \ldots, d_{jt}, \ldots, d_{mt}]$ where

$$d_{jt} = \begin{cases} 1 \text{ if and only if } \mu_{j-1} < Y_t \leq \mu_j \\ 0 \text{ if otherwise.} \end{cases}$$

Therefore, the likelihood of the tth farmer being in the jth financial soundness category is

$$Pr\{d_{jt} = 1\} = Pr\{\mu_{j-1} < Y_t \leq \mu_j\} = \Phi(\mu_j - \beta' X_t) - \Phi(\mu_{j-1} - \beta' X_t),$$

where Φ is the cumulative standard normal distribution function and the μs are unknown constants such that $\mu_1 = -\infty$, $\mu_m = +\infty$ and $\mu_1 < \mu_2 < \ldots < \mu_m$. Thus, the log-likelihood function for the model is

$$\log L(\beta) = \sum_{t=1}^{n} \sum_{j=1}^{m} d_{jt} \log[\Phi(\mu_j - \beta' X_t) - \Phi(\mu_{j-1} - \beta' X_t)].$$

The β vector which would maximize the log-likelihood function was solved for by maximum likelihood using the Davidon-Fletcher-Powell numerical optimization algorithm.

Results

The estimated model for financial soundness was statistically significant at the .001 level, as indicated by the chi-square test (Table 5). The model correctly classified 55 percent of the dairy farmers. One must note when examining the coefficients in Table 5 that the coefficients from the ordered response model do not have economic interpretation except for qualitative effects and for statistical testing of the significance of the independent variables. In order to gain an economic interpretation, the derivative of the probability with respect to the independent variable must be calculated. This investigation will be discussed after the qualitative effects and statistical significance of the variables are examined.

Table 5. Maximum Likelihood Coefficients of the Multi-ordered Response Analysis of Financial Soundness of Dairy Farmer Participants in the Dairy Termination Program, Four Southern States, 1986

Variable	Mean	Coefficient	Asymptotic t-Ratio	Significance Level
Intercept	—	.385	0.658	.510
COWS	1.207	.689	2.303	.021
BMKT	1.312	−.559	−2.032	.042
PNCT	0.860	.603	1.321	.186
AGE	51.060	−.016	−1.948	.051
ALABAMA[a]	0.181	−.055	−0.187	.851
LOUISIANA	0.181	.420	1.519	.129
MISSISSIPPI	0.319	−.396	−1.710	.087
Chi-square with 7 d.f.		24.839*		

*Significant at .001 level.

[a]Omitted Georgia, which is the base state in the group.

The size of the dairy herd and the volume of base marketings had the expected signs and were statistically significant at a level of less than 5 percent (Table 5). As the size of the herd increased, a dairy farmer was less financially sound. That may imply that dairy farmers increased their herd size through borrowing, which increased their debt load as well as decreasing their net income in order to service the debt load. Also, it may explain to some degree the reasons why about 22 percent of the dairy farmers with large herds of 150 or more cows were DTP participants.

Farmers with a greater volume of milk base marketings were in a sounder financial condition than those with smaller base marketings. Two farmers, each with the same number of cows but with different levels of production per cow, would be expected to be in different financial soundness classes, ceteris paribus. The farmer with the higher level of production per cow would be expected to have a higher net income and a lower debt-to-asset ratio, or as measured in this study, would have more funds remaining after paying off debts.

The coefficient for specialization in the dairy business, as indicated by the percentage of total farm income that was received from the dairy operation, had a sign opposite of that expected. However, it was not statistically significant until one went to the 18 percent level. The sign indicates that the more specialized a dairy farmer was the more likely that he was worse off financially. Implications are that specialization does not necessarily result in financially healthy operations.

The coefficient for age of operator was significant at the 5 percent level and had the expected sign. Older dairy farmers were financially sounder than younger ones. The asset-to-debt relationship should be better for older farmers resulting in a higher net income. That may be partially a result of purchasing land and other assets at more favorable prices than younger farmers. Being in a financially sound condition indicates that older dairy farmers exited dairy farming for reasons other than financial ones.

Dairy farmer participants in Mississippi were in a higher financial soundness class than those in Georgia, the base state. The sign of the coefficient for Alabama points to a slight advantage over Georgia while the sign for Louisiana points to a disadvantage compared with Georgia. However, the coefficients were not statistically significant for Louisiana until reaching a level of 0.129 and for Alabama at 0.851.

Probability derivatives were determined for each variable to show the effect of changes in the variable on the probability of a dairy farmer being in a certain financial soundness class. For discrete variables derivatives do not exist, but rather the actual probability associated with a given discrete variable, holding all other variables at the sample mean, is computed.

For an increase in a dairy herd of one hundred head, the dairy farmer's probability of being in the best financial soundness class (0) decreases by .274 of a probability point while his probability of being in the worst financial soundness class (2) increases by .203 of a probability point (Table 6). For an increase in one million pounds of milk base marketings, the probability of a farmer being in the best financial class increases by .222 of a probability point and being in the worst financial class decreases .165 of a probability point. A 60-year-old farmer would have a .14 probability point advantage over a 40-year-old farmer being in the best financial class and a .12

Table 6. Probability Derivative and Level of Dairy Farmers Being in a Specific Financial Soundness Class, Four Southern States, 1986

Variable	Financial Soundness Category		
	0	1	2
	Probability Derivative		
COWS	−.274	.071	.203
BMKT	.222	−.057	−.165
PNCT	−.239	.062	.177
AGE	.007	−.001	−.006
	Probability Level		
Alabama	.459	.322	.220
Georgia	.437	.327	.236
Louisiana	.281	.336	.383
Mississippi	.594	.274	.133

probability point advantage of not being in the worst class.

The more financially sound dairy farmer who exited dairy farming by way of the DTP was more likely to have been an older farmer with a smaller dairy herd and with relatively higher producing cows. The less financially sound dairy farmer who exited was more likely to have been one with a larger, less efficient producing herd of cows, and was more likely to be the younger farmer. For two contrasting states, farmers exiting in Mississippi were more likely to have been in the best financial class than farmers in Louisiana. Louisiana farmers were more likely to have been in the worst financial soundness class of the four states.

Summary and Conclusions

Low returns accompanied by relatively high debt were reasons hypothesized for the high participation in the DTP in some southern states. In an analysis of dairy farmer participants, those whose bids were accepted in four southern states, one-fourth indicated negative net income and nearly two-fifths indicated debt problems as reasons for exiting dairy farming. However, more than one-half indicated having profitable operations with little debt.

A two-dimensional variable was defined to assess the financial soundness of dairy farmers whose bids were accepted. It included net income in 1985 and the ability to pay off all debts with funds received as a result of participating in the DTP. Each dairy farmer was placed in one of three financial soundness classes based on their net income and asset-to-debt relationship.

A multiresponse ordered model was used to explain the factors contributing to a dairy farmer being in a given financial soundness class. The results showed that older farmers with smaller herds, but with relatively good production efficiency, were most likely to be financially sound. They exited dairy farming for reasons other than a poor financial condition. The DTP provided such farmers with an added income source for exiting.

Dairy farmers with larger herds were more likely to be less financially sound. A younger farmer, who expanded herd size through borrowing and possibly had not yet achieved a high level of production efficiency, was more likely to be in the lower financial soundness class. The DTP provided such dairy farmers a means and an opportunity to pay off debt obligations.

The analysis indicated differences among the four states in the probability of a dairy farmer participant being in a given financial soundness class. More financially sound farmers exited dairy farming in some states than in others for reasons other than their financial situation.

The methodology used in this analysis provides a means of identifying differences of the financial condition among dairy farmer participants. Factors were identified that influence financial soundness as well as measuring the probability of being in a given financial soundness class. This study represents only a subclass of dairy farmers who exited dairy farming by way of participation in a dairy program. The study showed a wide range of financial health. It suggests that additional research into the characteristics of participants in policy programs that are of a voluntary nature may prove beneficial to policy makers. Information from such research may be used to target agricultural policy that may attract farmers with certain characteristics including financial conditions.

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